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CUGA

Cumberland Gap National Historical Park Stream Monitoring Program

Assessment of Chemical and Biological Conditions
January through December 1993

Prepared by:

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and

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Knoxville, Tennessee

August 1994

NATIONAL PARK SERVICE
WATER RESOURCES DIVISION
FORT COLLINS, COLORADO
RESOURCE ROOM PROPERTY

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DEC 7 1994

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1. Introduction - purpose and scope

In the early 1980s, in Cumberland Gap National Historical Park (CUGA), preliminary construction was begun on a highway tunnel through Cumberland Mountain for the relocation of U. S. Hwy. 25E which at present follows the route of the old Wilderness Road through the Cumberland Gap. Tunnel excavation was completed by March 1993. A water monitoring program was initiated in 1990 by the National Park Service to monitor the effects, if any, of the construction on the waters, bed sediments, and biota of several streams in the park. The program was later joined by the University of Tennessee's Cooperative Park Studies Unit. Both the National Park Service and the Cooperative Park Studies Unit have generated several reports summarizing the analyses of water, sediment and benthos samples collected during the program (Nodvin and Rhodes, 1993a and b; 1994). In the immediate precursor to the present study, Moore and Smoot (1993) summarized the results of laboratory analyses performed on water and sediment samples collected from July 1991, through December 1992. The present report summarizes analytical results obtained from similar samples collected from January through December 1993; it also includes a summary of the results of benthic macroinvertebrate sampling from June 1990, to May 1993. In the report, trends in water and sediment quality and in benthic macroinvertebrate abundance are examined in relation to current and historical influences on park watersheds.

2. Sampling Program

A number of sampling stations were established on ten streams and associated areas in the park. In addition to the stations established to monitor the direct effects of tunnel construction, stations were established on streams which would be affected by the anticipated relocation of U. S. 25E and other proposed road improvements. Additional stations were located on back country streams to serve as project controls, others on Davis Branch to monitor conditions affecting the population of the threatened blackside dace (Phoxinus cumberlandensis), and still others near points of particular interest such as stockpiles of excavated tunnel materials. It was planned to sample some stations biweekly, others quarterly, and a number of the more important stations after storm events. The only presently active station (TC10) on Tunnel Creek, a stream which receives discharge directly from the tunnels, was sampled daily durung 1993, because tunnel construction was in progress. Sampling intervals were changed at various stations as the study progressed, and in several cases, sampling was discontinued prior to 1993. A list of the stations at which at least one water or sediment sample was collected in 1993, and their locations, is presented in Table 1. Stations, streams, and watersheds are described, and their associated maps are included in Appendix A .

3. In-stream Measurements and Sample Collection and Analysis

Several measurements of water properties are performed in the stream at the time of

Table 1. Sampling stations and locations in Cumberland Gap National Historical Park[1]

Sampling Stations	Location
Kentucky Stations	
YC5, YC5A, YC12	Little Yellow Creek
DB5, DB10	Davis Branch
MF2, MF5	Martins Fork
TC10	Tunnel Creek
SH10	Shillalah Creek
SR10	Sugar Run
988	Near intersection Hwy. 988 and U.S. 25E
DR9	Dark Ridge Creek
KY18	Proposed staging area upstream of YC5
RR1	Near end of existing railroad tunnel
Tennessee Stations	
GC3, GC4, GC7	Gap Creek
IF	Gap Creek near historical iron furnace site
TD1	Hwy. tunnel discharge outlet near Gap Creek
STOR1	Near intersection of U.S .58 and U.S. 25E
CAVE	Tunnel cavern
Virginia Stations	
ST5, ST10	Station Creek
LH5	Lewis Hollow (Unnamed stream)
CUDJO	Cudjo Cave

[1] Stations at which at least one water or sediment sample was collected in 1993

sample collection. A Hydrolab is used to measure temperature, pH, Eh, dissolved oxygen, and specific conductance, and a Marsh-McBirney Flomate 210D flowmeter and an H. F. Scientific DRT-15 C turbidimeter are used to measure flowrate and turbidity, respectively. Methods used to make field measurements and to obtain water and sediment samples are described in Curtis, et al. (Undated).

Most laboratory analyses are performed at Tennessee Technological University in Cookeville, Tennessee, although oil and Grease analyses (EPA Method 413.2) are performed at the park laboratory. Concentrations of major anions and cations are determined by means of an ion chromatograph (EPA Method 300.1) , and inductively coupled plasma analysis (ICP) (EPA Method 200.7) is used to determine concentrations of dissolved metals (Nodvin and Rhodes, 1993b). A total of 37 parameters are reported for regular (biweekly) samples and 47 for quarterly and storm event samples (Moore and Smoot, 1993). When both in-stream measurements and laboratory analyses are considered, a sample data report can include more than 50 parameters (Table 7).

4. Water Quality Criteria

Federal surface water quality criteria for aquatic life (Table 2) and federal drinking water standards (Table 3) serve as guidelines for use by the states in the development of their own water quality criteria (Smoot, et al., 1991). The surface water quality criteria adopted by Kentucky, Tennessee, and Virginia and approved by the U. S. Environmental Protection Agency are presented in Tables 4, 5, and 6, respectively. When these criteria are applied to an individual stream, they become the standards by which the water quality of that stream must be judged.

5. Water-quality results - 1993

5.1 Introduction

In this section, the parameter values determined at the stations on each stream are compared to the criteria of the state in which the stream is located in order to assess the stream's water quality. The comparisons are based on the 1993 water quality results contained in Appendix D. Many of the parameters reported by the CUGA water monitoring program are not found on any of the state lists of water quality criteria (Table 7); they are compared to federal criteria where possible.

Verbal comparisons of parameter values with state criteria are supplemented in several cases by graphical analyses in the form of Tukey box plots. Box plots are explained in Appendix

Table 2 . Selected federal water-quality criteria for freshwater aquatic life[1]

Constituent or Property	Toxicity Criteria	
	acute[2]	chronic[3]
Alkalinity (mg/L as $CaCO_3$)		> 20
Ammonia, total (mg/L)	Criteria pH and temperature dependent	
Arsenic, total trivalent (μg/L as As)	360	190
Cadmium, total (μg/L as Cd)	3.9*	1.1*
Chromium, total (μg/L as Cr)		
Chromium, hexavalent	16	11
Chromium, trivalent	1,700*	210*
Copper, total (μg/L as Cu)	18*	12*
Cyanide, total (μg/L as Cn)	0.022	0.0052
Dissolved oxygen (mg/L)	< 3.0-4.0	< 5.5
Iron, total (μg/L as Fe)		1,000
Lead, total (μg/L as Pb)	82*	3.2*
Mercury, total (μg/L as Hg)	2.4	0.012
Nickel, total (μg/L as Ni)	1,800*	96*
pH (Standard units)		6.5-6.9
Selenium, total (μg/L as Se)	260	35
Silver, total (μg/L as Ag)	4.1*	0.12
Temperature (° C)	Species-dependent criteria	
Zinc, total (μg/L as Zn)	320*	47

[1] (Smoot, et al. 1991)

[2] Highest 1-hour average concentration that should not cause unacceptable toxic effects in aquatic organisms during short-term exposure..

[3] Highest 4-day average concentration that should not cause unacceptable toxic effects in aquatic organisms during long-term exposure.

*Hardness level of 100 mg/L used to calculate criteria.

Table 3. Selected federal drinking-water standards[1]

Constituent or Property	MCL[2]	MCLG[3]	PMCL[4]	PMCLG[5]	SMCL[6]
Arsenic, total (μg/L)	50			50	
Barium, total (μg/L)	1,000			1,500	
Cadmium, total (μg/L)	10			5	
Chloride, dissolved (mg/L)					250
Chromium, total (μg/L)	50			120	
Copper, total (μg/L)			1,300	1,300	1,000
Dissolved solids, total (mg/L)					500
Fluoride, dissolved (mg/L)	4	4			2
Iron, total (μg/L)					300
Lead, total (μg/L)	50		5	0	
Manganese, total (μg/L)					50
Mercury, total (μg/L)	2			3	
Nitrogen, total nitrate (mg/L)	10			10	
Nitrogen, total nitrite (mg/L)				1	
pH (standard units)					6.5 - 8.5
Selenium, total (μg/L)	10			45	
Silver, total (μg/L)	50				
Sulfate, dissolved (mg/L)					250
Zinc, total (μg/L)					5,000

[1] (Smoot, et al., 1991)
[2] Maximum contaminant level
[3] Maximum contaminant level goal
[4] Proposed MCL
[5] Proposed MCLG
[6] Secondary MCL

Table 4. Selected Kentucky surface water-quality criteria[1]

Constituent or Property	Domestic water supply	Warmwater aquatic habitat	Coldwater aquatic habitat[2]	Recreational waters
Ammonia, total un-ionized (mg/L)		0.05		
Arsenic, total (μg/L as As)		50		
Barium, total (μg/L as Ba)	1,000			
Beryllium, total (μg/L as Be)		11 (soft) 1,100 (hard)		
Cadmium, total (μg/L as Cd)		4 (soft) 12 (hard)		
Chloride, dissolved (mg/L as Cl)	250	600		
Chromium, total (μg/L as Cr)	50	100		
Copper, total (μg/L as Cu)	1,000			
Cyanide, total (μg/L as Cn)		5		
Dissolved oxygen (mg/L)		< 4	< 5	
Dissolved solids, total (mg/L)	750			
Fecal coliform bacteria (colonies/100 mL)	2,000			200* 1,000**
Fluoride, dissolved (mg/L as F)	1			
Iron, total (μg/L as Fe)		1,000		
Lead, total (μg/L as Pb)	50			
Manganese, total (μg/L as Mn)	50			
Mercury, total (μg/L as Hg)		0.2		
Nitrogen, total nitrate (mg/L as N)	10			
pH (standard units)		6.0 - 9.0		6.0 - 9.0* 6.0 - 9.0**
Selenium, total (μg/L as Se)	10			
Silver, total (μg/L as Ag)	50			
Sulfate, dissolved (mg/L as SO_4)	250			
Temperature (° C)		<31.7	***	
Zinc, total (μg/L as Zn)		47		

[1] (Smoot et al. 1991)

[2] Warmwater aquatic habitat criteria apply where none established for coldwater habitats.

* primary contact recreation

** secondary contact recreation

*** not to exceed natural seasonal variations

(soft) water has an equivalent concentration of calcium carbonate of 0 to 75 milligrams per liter

(hard) water has an equivalent concentration of calcium carbonate of over 75 milligrams per liter

Table 5. Selected Tennessee surface water quality criteria[1]

Constituent or Property	Domestic water supply	Freshwater fish and aquatic life Maximum Concentration	Freshwater fish and aquatic life Continuous Concentration	Recreation
Antimony (μg/L)				4310
Arsenic, total (μg/L)	50	360	190	
Beryllium (μg/L)				1.3
Cadmium (μg/L)**	10	4*	1*	
Chromium, total (μg/L)	50		100	
Copper (μg/L)**		18*	12*	
Cyanide (μg/L)	22	5.2		
Dissolved oxygen (mg/L)			> 5	
Lead (μg/L)**	50	82*	3*	
Mercury (μg/L)	2	2.4	0.012	0.2
Nickel (μg/L)**		1,400	160	10
pH (standard units)			6.5 - 8.5	6.0 - 9.0
Selenium (μg/L)	10	20	5	
Silver (μg/L)	50	4*		
Temperature (° C)			< 30.5	< 30.5
Zinc (μg/L)**		117*	106*	1*

[1] (Tennessee Department of Environment and Conservation, 1991)

* Dissolved

** Hardness level of 100 mg/L used to calculate criteria

Table 6. Selected Virginia surface water quality standards for freshwater[1]

	Aquatic Life		Human Health	
	Exposure Level		Water Supply	
Constituent or Property	Acute[2]	Chronic[3]	Public	All other
Arsenic (μg/L)			50	
Arsenic III (μg/L)	360	190		
Barium (μg/L)			2,000	
Cadmium (μg/L)	3.9[4]	1.1[4]	16	170
Chloride (μg/L)	860,000	230,000	260,000	
Chromium III (μg/L)	1,737[4]	207[4]	33,000	670,000
Chromium VI (μg/L)	16	11	170	3,400
Copper (μg/L)	17.7[4]	11.8[4]	1,300	
Cyanide (μg/L)	22	5.2	700	215,000
Dissolved oxygen (mg/L)	4[5]	5[6]		
Iron, soluble (μg/L)			300	
Lead (μg/L)	81.7[4]	3.2[4]	15	
Manganese, soluble (μg/L)			50	
Mercury (μg/L)	2.4	0.012	0.144	0.146
Nickel (μg/L)	1,418[4]	157[4]	607	4,583
Nitrate, as N (μg/L)			10,000	
pH (standard units)		6.0 - 9.0		
Phosphorous, as P (μg/L)			21,000	4,600,000
Selenium (μg/L)	20	5	172	11,200
Silver (μg/L)	4.1[4]			
Sulfate (μg/L)			250,000	
Temperature (° C)		31		
Total dissolved solids (μg/L)			500,000	
Zinc (μg/L)	117[4]	106[4]	5,000	

[1] (Virginia Water Control Board, 1992)

[2] One-hour average concentration not to be exceeded more than once every three years

[3] Four-day average concentration not to be exceeded more than once every three years

[4] Hardness level of 100 mg/L used to calculate criteria

[5] Minimum standard

[6] Daily average

Table 7. A comparison of inorganic constituents and physical properties.

Constituent or Property	CUGA Water [1]	CUGA Sediment[1]	Federal DW[2]	Federal AQ[3]	KY[4]	TN[5]	VA[6]
Aluminum	+	+					
Aluminum, total	+						
Ammonia				+	+		
Antimony						+	
Arsenic	+	+	+	+	+	+	+
Barium	+	+	+		+		+
Beryllium					+	+	
Bicarbonate	+						
Boron	+	+					
Bromine	+	+					
Cadmium	+	+	+	+	+	+	+
Calcium	+	+					
Carbon, total		+					
Carbon, total organic	+	+					
Carbonate	+						
Chloride	+	+	+		+		+
Chromium	+	+	+	+	+	+	+
Cobalt		+					
Copper	+	+	+	+	+	+	+
Cyanide				+	+	+	+
Fluoride	+	+	+		+		
Germanium		+					
Iron, total	+		+	+	+		
Iron	+	+					+
Lead	+	+	+	+	+	+	+
Lithium	+	+					
Magnesium	+	+					
Manganese, total	+				+		
Manganese	+	+	+				+
Mercury	+	+	+	+	+	+	+
Molybdenum	+	+					
Nickel	+	+		+		+	+
Nitrate	+	+	+		+		+
Nitrite	+	+	+				
Orthophosphate	+	+					
Phosphorous	+	+					+
Phosphorous, total							+
Potassium	+	+					
Selenium			+	+	+	+	+
Silicon	+	+					
Silver			+	+	+	+	+
Sodium	+	+					
Strontium	+	+					
Sulfate	+	+	+		+		+
Sulfur, total		+					
Titanium	+	+					
Vanadium	+	+					
Zinc	+	+	+	+	+	+	+

(Continued)

Table 7. (Continued). A comparison of inorganic constituents and physical properties.

Properties, measurements and miscellaneous variables							
Constituent or Property	CUGA Water [1]	CUGA Sediment[1]	Federal				
			DW[2]	AQ[3]	KY[4]	TN[5]	VA[6]
Acidity	+	*					
Acid-base account, net		+					
Alkalinity	+	**		+			
Anions	+						
Anion-cation ratio	+						
Cations	+						
Color	+						
Eh	+						
Flowrate (Discharge)	+						
Hardness	+						
Oil & grease	+						
Oxygen, dissolved	+			+	+	+	+
pH	+	***	+	+	+	+	+
Temperature	+			+	+	+	+
Turbidity	+						
Sediment, total suspended	+						
Solids, total dissolved	+		+		+		+
Specific conductance	+						

[1] Present study
[2] (Smoot, et al., 1991)
[3] (Smoot, et al., 1991)
[4] (Smoot, et al., 1991)
[5] (Tennessee Department of Environment and Conservation, 1991)
[6] (Virginia Water Control Board, 1992)
* Potential acidity
** Neutralization potential
*** Paste pH

G. The plots, depicting the distribution of measured values, were prepared for each parameter at several stations when sufficient data were available. Generally, this meant that a station was sampled biweekly and that most values were above the detection limit. Constituent concentrations reported as zero were censored by adjusting them to the detection limit.

5.2 Flow rate (Discharge)

The flow rate, or discharge, is a measure of the amount of water passing a given point in a stream in a given time period. In the data upon which this study is based, the flow rate measured at each station at each sampling period is reported in cubic feet per second. Although flow rate is not a water quality parameter, high flow rates, caused by storms, for instance, can significantly affect water quality by resuspending the bottom sediments which settled out of the water column during periods of lower flows , thus increasing the total concentrations of constituents by the amounts which are sorbed to the sediments. In addition, various species of aquatic organisms are adapted to the differences in flow rate which are present in riffle and pool areas of a stream.

In Kentucky waters, flow rates were generally less than 5.0 cfs in Davis Branch and Tunnel Creek and at RR1. Flow rates generally ranged from near zero to around 20 cfs in Little Yellow Creek stations YC5 and YC5A and to around 45 cfs at YC12. At all of these stations, uncharacteristically high flows occurred occasionally (Figure 1), and in several instances, flows occurred which were too high to measure. In Tennessee, flows at Gap Creek stations normally ranged from near zero to about 18 cfs except at GC4 (which is actually located on a tributary to Gap Creek) where flows were generally less than 1.0 cfs (Figure 2).

5.3 Temperature

Kentucky and Tennessee water quality criteria for the protection of aquatic life require water temperatures to be less than 31.7° C and 30.5° C, respectively, for warmwater streams. Virginia requires that streams in mountainous regions have water temperatures less than 31° C. In Kentucky, the temperature criterion was not found to be exceeded at any sampling station on Davis Branch or Little Yellow Creek. Seventy-five percent of the observed temperatures in those streams were less than 20° C except at YC12 (Figure 3). At both SH10 and 988 which were sampled only in the winter and spring, measured temperatures were equal to or lower than 11° C. Three quarterly samples in winter, spring, and fall found temperatures at Martins Fork stations to be lower than 11.5 ° C. In Tennessee, temperatures at Gap Creek stations were rarely found to exceed 20° C (Figure 4). In Virginia, water temperatures measured on the same dates at ST5, ST10, and LH5 were lower than 10.5 ° C.

5.4 Dissolved oxygen

In both Kentucky and Virginia, water quality criteria for the protection of aquatic life require that dissolved oxygen concentrations be at least 4 mg/L in warmwater streams. In Kentucky, levels below the minimum were measured at DB5 on Davis Branch. Moore and Smoot (1993) used data from Davis Branch to demonstrate the inverse relationship between temperature and dissolved oxygen concentration. All of the three low levels at DB5 were associated with periods of water temperatures from 19.3 to 22.0 ° C. At YC5 on Little Yellow Creek, dissolved

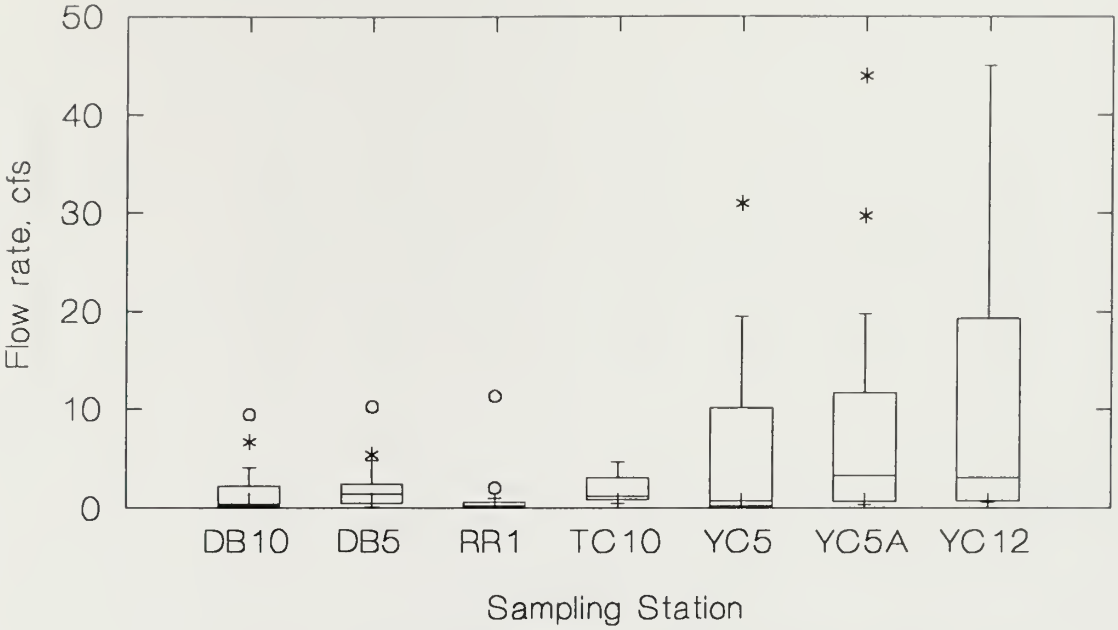

Figure 1. Flow rate distribution at Kentucky stations - 1993
(See Appendix G for explanation of boxplot)

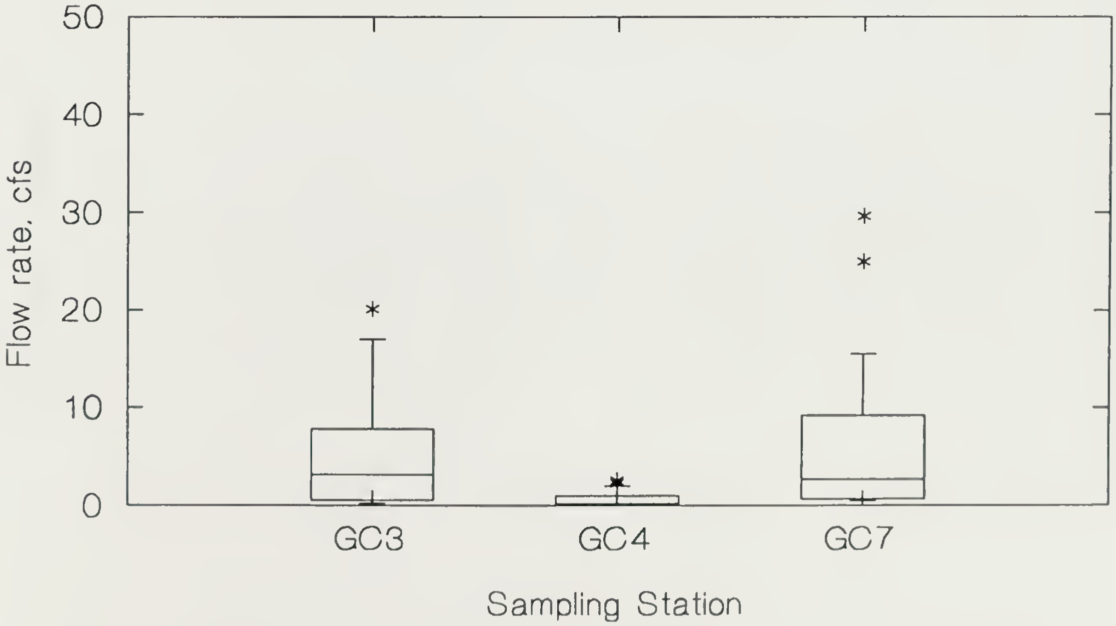

Figure 2. Flow rate distribution at Tennessee stations - 1993
(See Appendix G for explanation of boxplot)

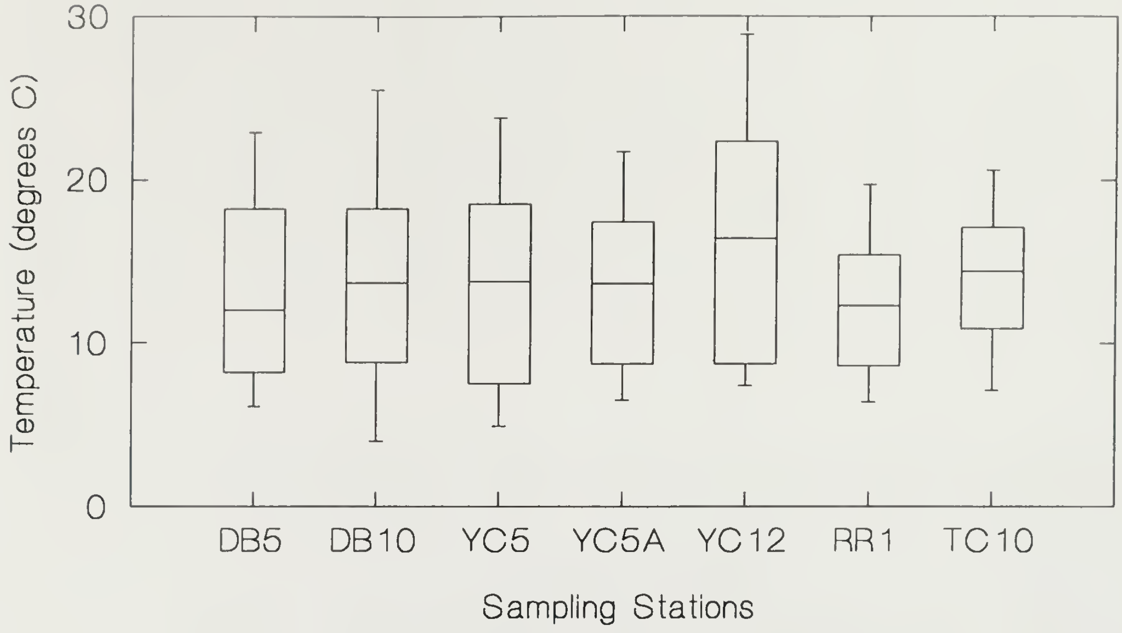

Figure 3. Temperature distribution at Kentucky stations - 1993
(See Appendix G for explanation of boxplot)

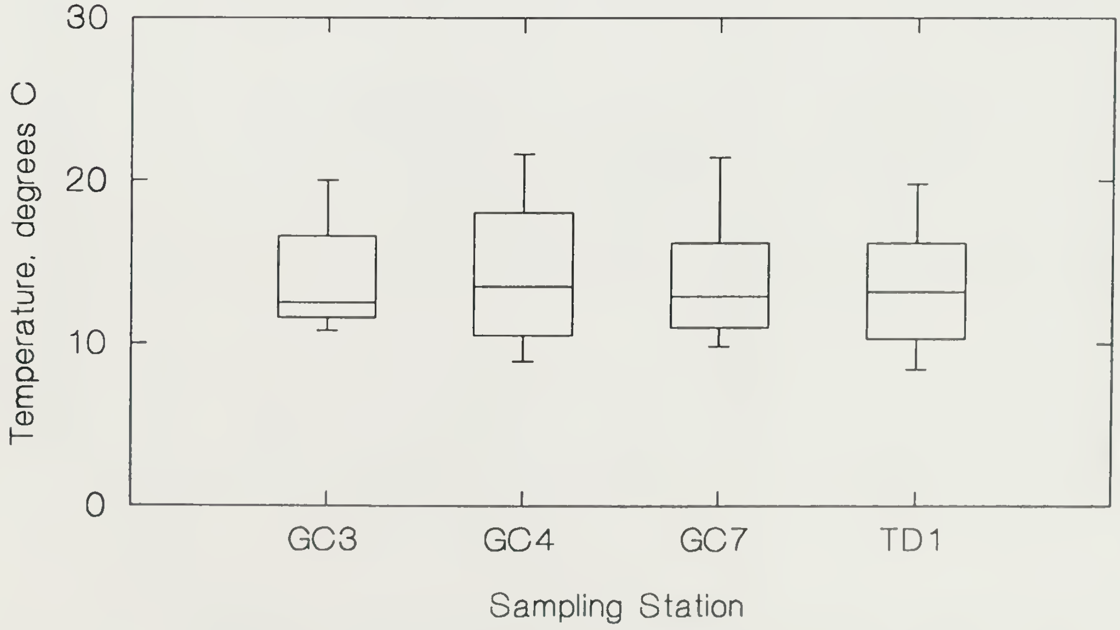

Figure 4. Temperature distribution at Tennessee stations - 1993
(See Appendix G for explanation of boxplot)

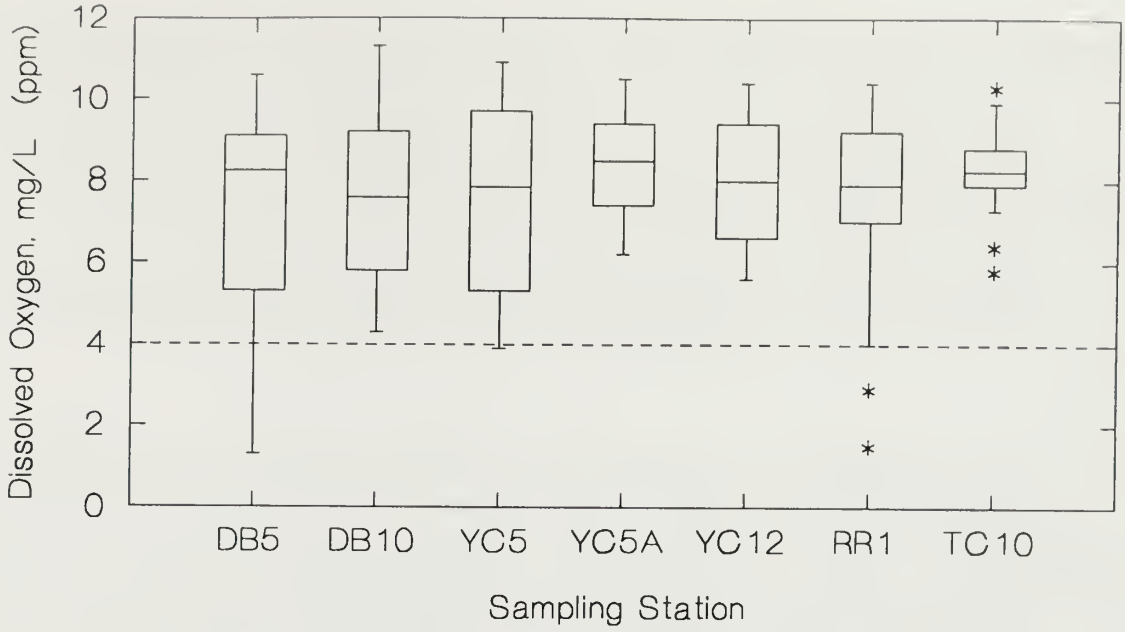

Figure 5. Dissolved oxygen distribution at Kentucky stations - 1993
(Dotted lines represent state criteria limits.
See Appendix G for explanation of boxplot.)

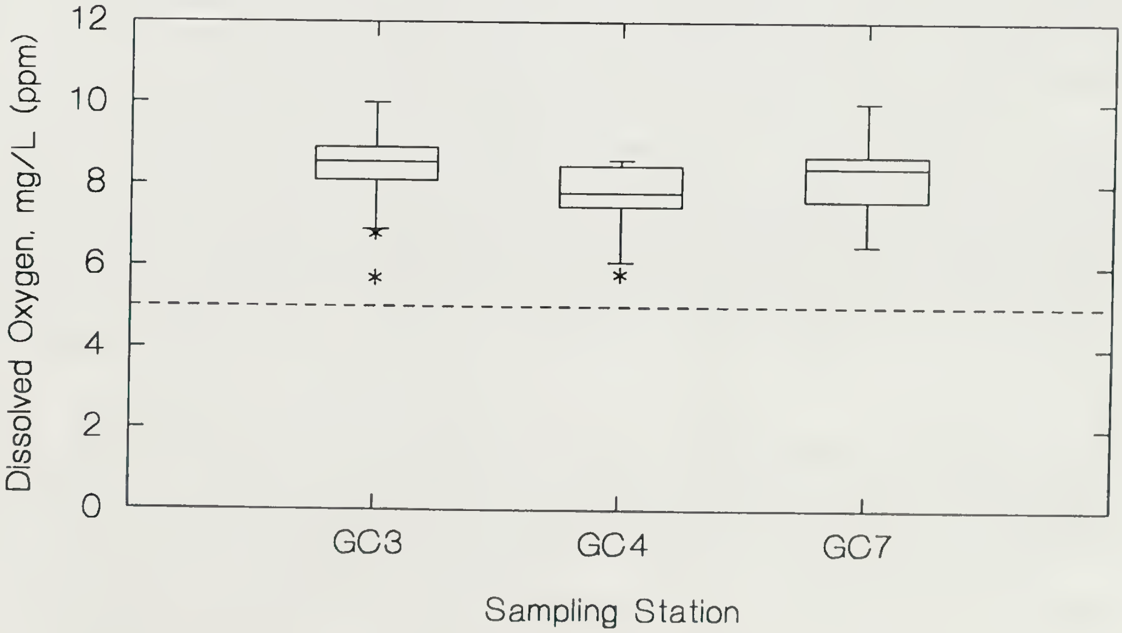

Figure 6. Dissolved oxygen distribution at Tennessee stations - 1993
(Dotted lines represent state criteria limits.
See Appendix G for explanation of boxplot.)

oxygen levels were barely below the 4 mg/L criterion on three occasions at temperatures ranging from 15.5 to 23.8° C; however, low levels were measured twice at RR1 at temperatures of only 7.2 and 13.5° C. No dissolved oxygen concentrations below 4 mg/l were measured at other stations on Little Yellow Creek or Tunnel Creek (Figure 5) or at any other sampling station in Kentucky. In Tennessee, dissolved oxygen levels were higher than the 5 mg/L criterion at all Gap Creek stations, but low concentrations occurred in the tunnel discharge on several occasions (Figure 6). All concentrations measured at other Tennessee stations were above the criterion level. In Virginia, dissolved oxygen concentrations were higher than 4 mg/L at all sampling periods.

5.5 pH

The pH of an aqueous solution is defined as the negative base-10 logarithm of the hydrogen ion activity and can range from 0 (very acidic) to 14 (very alkaline) (Smoot, et al., 1991). The pH in natural waters normally ranges from about 6.0 to 8.5 (Hem, 1985), because these streams have achieved equilibrium with the surrounding weathered rocks and minerals of the surface. When runoff from construction materials such as shotcrete or from unweathered subsurface materials exposed by construction reaches a stream, large pH fluctuations may result which can cause severe harm to aquatic organisms living downstream from the point of entry of the runoff. Kentucky and Virginia water quality criteria for the protection of aquatic life require that pH be in the range 6.0 to 9.0 units, whereas Tennessee criteria specify a range of 6.5 to 8.5 units.

In Kentucky, pH levels in regular samples were above the Kentucky criterion on a few occasions in Tunnel Creek and in Little Yellow Creek at YC5A (Figure 7) which is only about 50 feet downstream from the mouth of Tunnel Creek. However, a considerable amount of acid was added to Tunnel Creek in 1993 (Nodvin and Rhodes, 1993b) to neutralize basic conditions caused by shotcreteing, and daily pH levels at TC10 ranged as low as 3.7 and 3.4 on 1/30/93 and 2/13/93, respectively, and as high as 11.9 on 2/6/93 (Appendix H). At Station 988, all pH values were within the specified range, but acidic conditions appeared to be present throughout the year in Shillalah Creek and Martins Fork, which reportedly are normally acidic streams. In Tennessee, pH values in Gap Creek and the tunnel discharge were between 6.5 and 8.5 units (Figure 8) as was drainage from the stockpile at STOR1. In Virginia, pH values in Station Creek and at LH5 were within criteria limits.

5.6 Alkalinity

The alkalinity of a water may be defined as the capacity of the solutes it contains to react with and neutralize acid. The principal source of the carbonate and bicarbonate ions that produce alkalinity in water is the CO_2 gas in the atmosphere (Hem, 1985) which forms a weak solution of carbonic acid, H_2CO_3, when it combines with rainwater. In areas of limestone geology, the carbonic acid solution dissolves carbonate-rich material as it sinks to the water table and moves through the subsurface. When it enters a stream as base flow, the dissolved carbonates become an important source of alkalinity. Alkalinity is important to aquatic life because it acts as a buffer

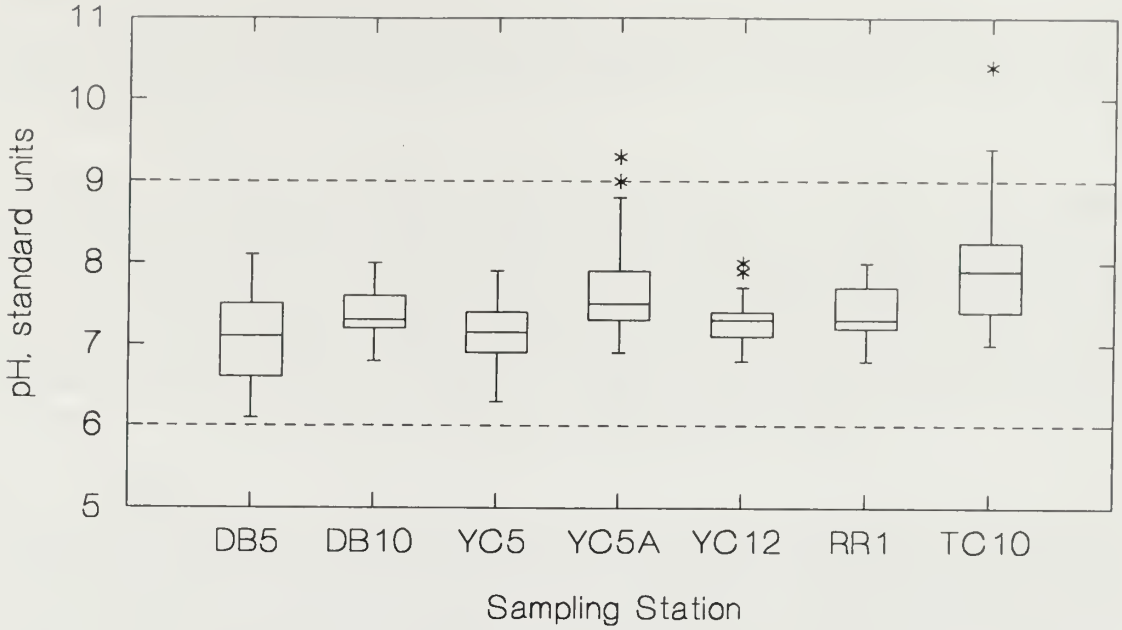

Figure 7. pH distribution at Kentucky stations - 1993
(Dotted lines represent state criteria limits)
(See Appendix G for explanation of boxplot)

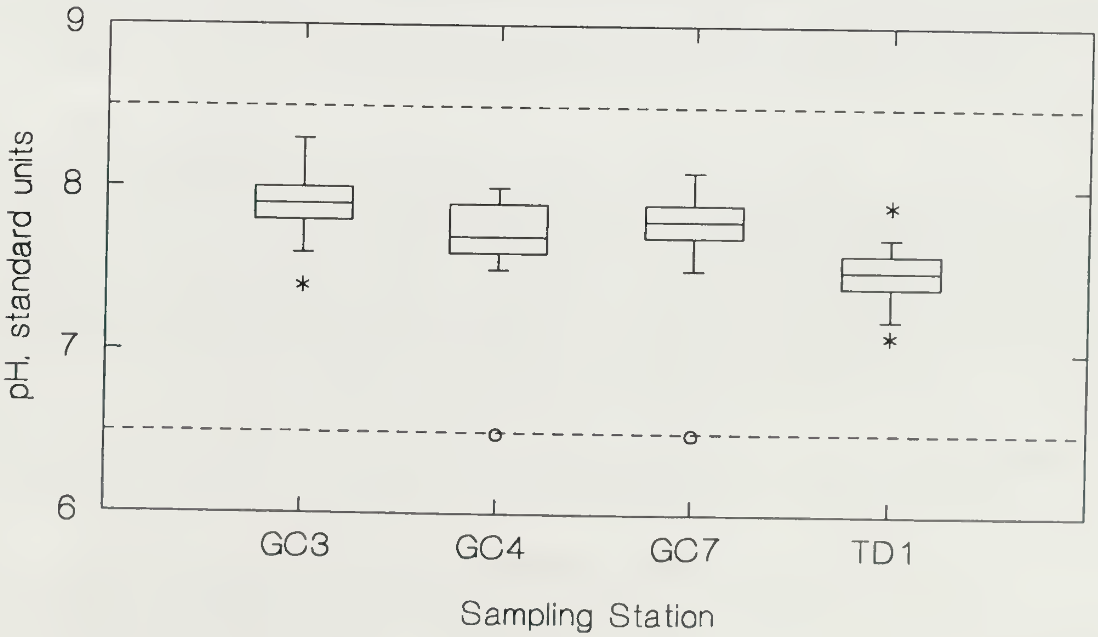

Figure 8. pH distribution at Tennessee stations - 1993
(Dotted lines represent state criteria limits)
(See Appendix G for explanation of boxplot)

to keep the pH within tolerable limits by neutralizing acidic materials entering the stream. Neither Kentucky, Tennessee, nor Virginia has established water quality criteria for alkalinity; however, federal criteria (Table 2) specify that not less than 20 mg/L as $CaCO_3$ should be present for the protection of aquatic life.

In Kentucky, alkalinity was below 20 mg/L in about 30 percent and 50 percent of samples from DB10 and DB5, respectively. At Little Yellow Creek stations, it was below that figure in about 50 percent of samples from YC5 and YC12 and about 35 percent of samples from YC5A. Alkalinity levels were greater than 20 mg/L throughout the year at TC10, RR1, and 988, but they were very low in the acidic Shillalah Creek and Martins Fork. In Tennessee, alkalinity levels were consistently above federal criteria at all stations. In Virginia, alkalinity levels ranged from 12 to 60 mg/L in Station Creek and from 8.6 to 38 mg/L at LH5 in Lewis Hollow.

5.7 Acidity

Acidity is a measure of the capacity of a water to neutralize a strong base. According to Hem (1985), strongly acid water may be produced by the oxidation of sulfide minerals exposed to the air by mining operations, and in some areas, natural sediments at or near the surface may contain enough reduced minerals to significantly increase the acidity of natural runoff. Mining operations are not noticeably affecting park streams at present, but runoff from naturally acidic sediments may be contributing to the acidity of Shillalah Creek and Martins Fork. Neither Kentucky, Tennessee, Virginia, nor the federal government has established water quality criteria for acidity.

In Kentucky, only Shillalah Creek and Martins Fork had measurable acidity ranging from below detection limits to 7.5 mg/L. In Tennessee, measurable acidity was not encountered at any stations. In Virginia, none of the sampled streams were found to have measurable acidity.

5.8 Redox potential

The redox potential is a numerical index of the intensity of oxidizing or reducing conditions within a system. Positive potentials indicate that the system is relatively oxidizing, and negative potentials indicate that it is relatively reducing. Eh values relate to ratios of solute activities and give little or no indication of the quantitative capacity of the system to oxidize or reduce material that might be introduced from outside. pH - Eh relationships are useful for predicting and defining equilibrium behavior of multi-valent elements (Hem, 1985).

Measured values of the redox potential generally ranged from 273 to 672 indicating oxidizing conditions in park waters. One value of 75 was measured at YC5A on 3/23/93.

5.9 Anion/cation ratio, specific conductance, and total dissolved solids

Stream water contains a number of dissolved inorganic constituents derived from dissolution of minerals in the streambed or from point or nonpoint sources external to the stream. As the minerals enter solution, they dissociate into positively charged cations or negatively charged anions.

5.9.1 Anion/cation ratio

Since on a macro scale, the positive and negative ionic charges must be in balance , the anion/cation ratio provides a rough indication of whether a water quality analysis was performed properly. The closer the ratio approaches a value of one, the more nearly equal the charge balance. In about 13 percent of samples for which an anion/cation ratio was reported, its value was less than 0.85 or greater than 1.15. Thus, it appears probable that some samples should be reanalyzed. Calculation of the anion-cation balance discussed by Nodvin and Rhodes (1993a) could provide a simple means of determining which samples should be returned for reanalysis if, as they suggest, the criterion of Hillman, et al. (1986) is followed and a sample is reanalyzed when the absolute value of its ion difference exceeds 15 percent.

5.9.2 Specific conductance and total dissolved solids

Specific conductance is the measure of the ability of water to conduct an electrical current. It is related to the quantity and types of ionized substances in water. Dissolved solids consist of inorganic salts and other dissolved materials such as organic matter. By multiplying specific conductance in microsiemens per centimeter by 0.6, an estimate of the dissolved solids concentration in milligrams per liter is obtained (Smoot, et al., 1991). When measurements of both parameters are available, they can be used to provide a check on the accuracy of the analysis. The dissolved solids value in milligrams per liter should generally be from 0.55 to 0.75 times the specific conductance in microsiemens per centimeter (Hem, 1985). Neither Kentucky, Tennessee, or Virginia has established a criterion for specific conductance or total dissolved solids for the protection of aquatic life; however, Kentucky and Virginia have established criteria of 750 and 500 mg/L, respectively, for total dissolved solids in domestic and public water supplies. The federal drinking water standard is 500 mg/L.

In Kentucky, total dissolved solids concentrations were found to be generally less than 250 mg/L at stations on Davis Branch, Little Yellow Creek, Tunnel Creek, and at RR1 (Figure 9). They were extremely low in quarterly samples from Shillalah Creek and Martins Fork with high values of 12 and 8 mg/L, respectively, but at 988, where the sampling effort was restricted to five samples in spring and winter, total dissolved solids levels ranged from 210 to 597 mg/L. These values, though higher than at other stations, are still well below the Kentucky criterion. In Virginia, total dissolved solids values in Station Creek and the Lewis Hollow drainage were well below the Virginia criterion, ranging from 24 to 76 mg/L. In Tennessee, total dissolved solids values ranged from 37 to 255 mg/L in all samples.

5.10 Major cations

Those ions making up the bulk of the total dissolved solids in a stream are referred to as major cations or major anions. According to Nodvin and Rhodes (1993a;b), major cations in streams within the park include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), ammonium (NH_4^{+}), and hydrogen ion (H^{+}). Neither Kentucky, Virginia, Tennessee, nor the federal government has established water quality criteria for any of the major cations. No

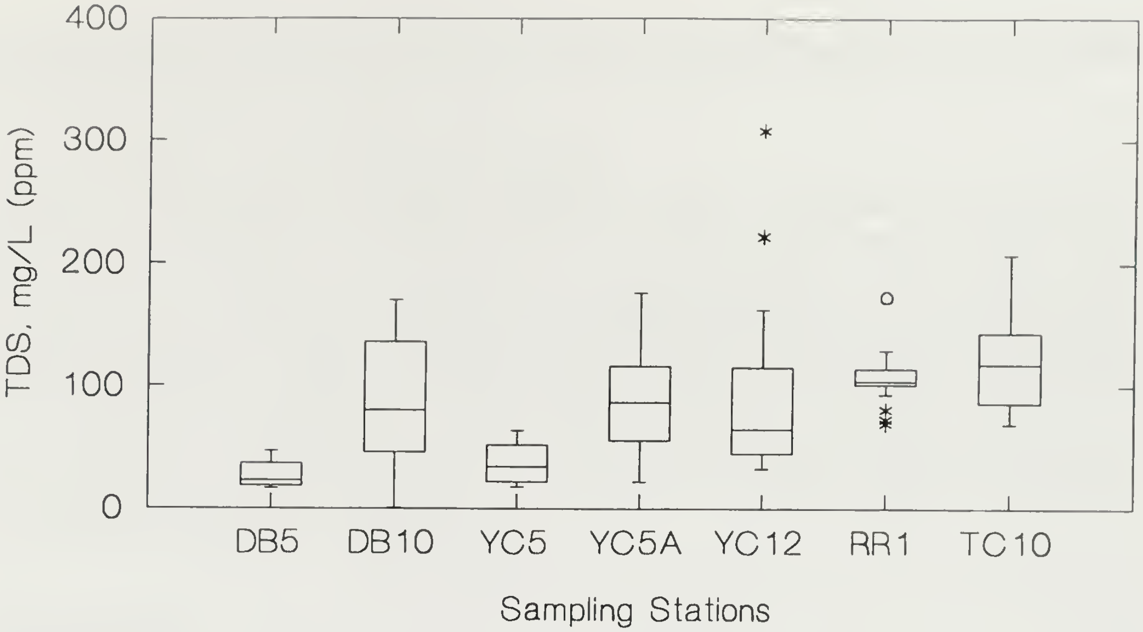

Figure 9. Total dissolved solids distribution at Kentucky stations - 1993
(See Appendix G for explanation of boxplot)

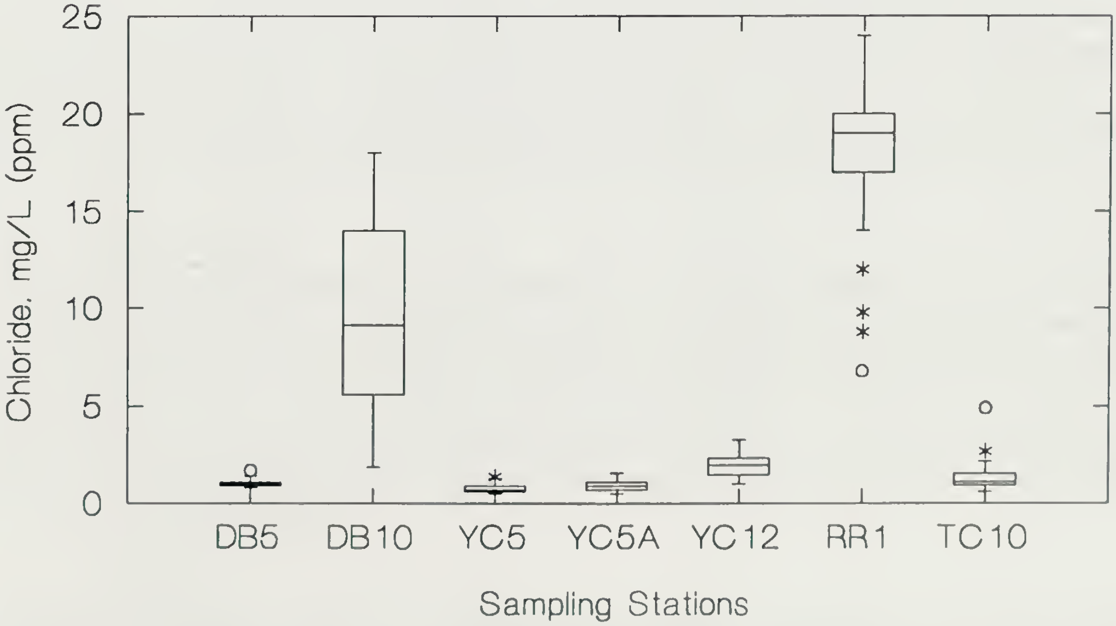

Figure 10. Chloride distribution at Kentucky stations - 1993
(See Appendix G for explanation of boxplot)

analysis is performed for ammonium in this study (Table 7), and the hydrogen ion concentration can be calculated from the formula $[H^+] = 10^{-pH}$.

5.10.1 Calcium , magnesium, and hardness

Calcium and magnesium are essential elements for plants and animals, and calcium is a major component of the solutes in most natural water. The sum of their concentrations (usually reported as mg/L of $CaCO_3$) is known as hardness (Nodvin and Rhodes, 1994). Hardness is a quality which is of more value in determining the suitability of a water for domestic use than in determining its suitability for aquatic life, since it primarily affects the efficiency of soap and the clogging of water lines with precipitate. Many domestic water supplies are softened to less than 100 mg/L of hardness as $CaCO_3$ (Hem, 1985). In the present study ,calcium concentrations ranged from 0.4 to 91.7 mg/L as Ca, magnesium from 0.3 to 22.0 mg/L as Mg, and hardness from 3 to 260 mg/L as $CaCO_3$ at all stations.

5.10.2 Sodium

Sodium occurs in virtually all surface water, although its concentration varies widely. Potential sources of sodium in the study area include de-icing salts, domestic sewage, and industrial effluents (Smoot, et al., 1991). Neither Kentucky, Tennessee, Virginia, or the federal government have established water-quality standards for sodium for the protection of aquatic life or for water supplies. Sodium concentrations in samples ranged from below detection limits to 63 mg/L.

5.10.3 Potassium

Potassium concentrations in most natural waters are much lower than sodium concentrations due to the tendency of potassium to combine with clay minerals. Sources of potassium include the feldspars orthoclase and microcline and leachate from dead plant material such as dead leaves (Hem, 1985). Neither Kentucky, Tennessee, Virginia, nor the federal government has established water-quality standards for potassium for the protection of aquatic life or for water supplies. Potassium concentrations in samples ranged from 0.3 to 7.8 mg/L.

5.11 Major anions

Major anions include chloride(Cl^-), fluoride (F^-), nitrite (NO_2^-), nitrate (NO_3^-), sulfate (SO_4^{2-}), and bicarbonate (HCO_3^-). At pHs greater than 10, significant amounts of carbonate (CO_3^{2-}), and hydroxyl (OH^-) may be present. The federal drinking water standards list proposed limits for nitrate and nitrite. Kentucky and Virginia have established chloride criteria for the protection of aquatic life and nitrate and sulfate criteria for public water supplies. Kentucky alone has a fluoride criterion for public water supplies, and Tennessee has not established water-quality criteria for any of the major anions.

5.11.1 Chloride

Chloride is similar to sodium in its widespread occurrence and its varying concentrations in surface waters. As with sodium, potential sources of chloride in the study area include de-icing

salts, domestic sewage, and industrial effluents (Smoot, et al., 1991). The Kentucky chloride criterion is 600 mg/L as Cl for warmwater aquatic habitats, and the Virginia criterion for the protection of aquatic life is 860 mg/L for acute exposure and 230 mg/L for chronic exposure. At all sampling stations in Kentucky (Figure 10), Virginia, and Tennessee, measured chloride levels were generally less than 25 mg/L.

5.11.2 Fluoride

According to Hem (1985), the inclusion of fluoride among the major anions is arbitrary, since concentrations present in most natural waters are less than 1.0 mg/L. The Kentucky criterion for fluoride in water supplies is 1.0 mg/L. Sample concentrations of fluoride in this study ranged from below detection limits to 0.5 mg/L.

5.11.3 Nitrate and nitrite

Nitrate and nitrite are the anionic forms of nitrogen which occur in water. Point sources of nitrogen contamination include municipal and industrial wastewater and feedlot runoff. Nonpoint sources include fertilizers, leachate from dumps or landfills, and leachate from septic tank drainfields. Nitrate is an important plant nutrient and is a factor in causing nuisance phytoplankton blooms in lakes; however, this effect is rarely seen in free-flowing streams (Smoot, et al., 1991). The occurrence of nitrate and nitrite in water has been extensively studied because of the public health relationship, since concentrations of nitrate in excess of 10 mg/L as N may cause methemoglobinemia in small children (Hem, 1985). Federal drinking water standards set proposed limits of 10 mg/L as N for nitrate and 1.0 mg/L as nitrite for nitrite. Kentucky and Virginia have also established 10 mg/L as N criteria for nitrate, but they have not established criteria for nitrite. Tennessee has not established criteria for either nitrate or nitrite.

In Kentucky, nitrate concentrations ranged from below detection limits to 8.5 mg/L (1.9 mg/L as N) at most sampling stations; however, at 988, nitrate concentrations ranged from 13.0 to 30.0 mg/L (2.9 to 6.8 mg/L as N). Nitrite concentrations at Kentucky stations generally ranged from below detection limits to about 1.0 mg/L as nitrite; however, in two April samples at DB5, nitrite concentrations were measured at 2.0 and 2.1 mg/L as nitrite. In Virginia, nitrate concentrations ranged from below detection limits to 0.5 mg/L (0.1 mg/L as N), and all nitrite concentrations were below detection limits. In Tennessee, nitrate concentrations ranged from below detection limits to 6 mg/L (1.4 mg/L as N), and nitrite concentrations ranged from below detection limits to 1.0 mg/L as nitrite.

5.11.4 Sulfate

Sulfur is an essential element in the life processes of plants and animals. It is widely distributed in reduced form in igneous and sedimentary rocks as metallic sulfides. When sulfide minerals undergo weathering in contact with aerated water, the sulfate is oxidized to yield sulfate ions that go into solution in the water (Hem, 1985). In the park, an important source of sulfate anions may be the calcium sulfate ($CaSO_4$) that is used to neutralize basic conditions caused by tunnel construction. The federal government, Kentucky, and Virginia have established water

quality criteria of 250 mg/L for sulfate in water supplies. Tennessee has not established sulfate criteria. Sulfate concentrations in samples ranged from below detection limits to 190 mg/L.

5.11.5 Carbonate and Bicarbonate

Carbonate and bicarbonate ions are important contributors to alkalinity, which controls the pH of natural waters. In samples with pH > 10, significant amounts of hydroxyl and carbonate may be present. Samples with moderate pH levels may contain both carbonate and bicarbonate ions, but samples with pH values from 4 to 6 would contain only bicarbonate (Nodvin and Rhodes, 1993). No criteria have been established which specifically address the concentrations of carbonate and bicarbonate. No values for carbonate concentrations were reported for the study. Bicarbonate concentrations in samples ranged from below detection limits to about 140 mg/L.

5.12 Suspended sediment, turbidity, and color

Large amounts of suspended sediment may adversely affect the biological community of a stream. It can also transport sorbed metals, organics, and nutrients, and it is aesthetically displeasing. Turbidity is a measure of suspended sediment that is based on the amount of light which is able to pass through the suspension. The less transmitted light which is measured, the higher the apparent turbidity. Thus, there is a direct relationship between suspended sediment concentrations and turbidity. Color, which is imparted to water by dissolved materials leached from organic debris such as dead leaves (Hem, 1985), can produce artificially high turbidity readings by absorbing light, thus decreasing the amount of light which is transmitted. No water quality criteria have been established by the federal government or by Kentucky, Tennessee, or Virginia which address suspended sediment concentrations, turbidity, or color. Polymer and alum were added to the tunnel effluent to control suspended sediment and turbidity.

Total suspended sediment concentrations generally ranged from below detection limits to about 94 mg/L, but in samples collected on 3/23/93, suspended sediment concentrations ranged from 123 to 715 mg/L. Daily suspended sediment concentrations ranged from below detection limits to 302 mg/L at TC10 (Appendix H). Turbidities generally ranged from below detection limits to 57 ntu; however, turbidity levels of 200 ntu were measured at most stations on 3/23/93, and a level of 425 ntu was measured at YC5A on that date. Sample color values generally ranged from below detection limits to about 40 Pt-Co with a high of 176 Pt-Co at YC5A on 3/23/93.

5.13 Plant nutrients

Among the major nutrients which aquatic vascular plants and algae require for growth are the elements phosphorous, potassium, and nitrogen. The forms of nitrogen available for plant growth, ammonium, nitrate, and nitrite, of which nitrate is predominant, have already been discussed (Sections 5.10 and 5.11.3). Potassium was discussed in Section 5.10.3.

5.13.1 Phosphorous

Phosphorous is the major nutrient which is most frequently determined to be limiting to plant growth. Some of the more important sources include the breakdown and erosion of phosphorous-bearing minerals, decaying organic material, fertilizers, detergents, sewage effluents,

and septic tank leachates (Smoot, et al., 1991). Dissolved phosphorous is likely to be present as the orthophosphates $H_2PO_4^-$ and HPO_4^{2-} at the pH levels present in park streams (Hem, 1985). Dissolved phosphorous is reported in units of mg/L as P. Orthophosphate is reported in units of mg/L as PO_4.

No water-quality criteria for dissolved phosphorous have been established by the federal government, Kentucky, or Tennessee. Virginia has established a criterion for dissolved phosphorous of 21 mg/L as P for public water supplies and 4,600 mg/L as P for all other water supplies. Both dissolved phosphorous and orthophosphate were generally below detection limits at all stations, but occasional higher concentrations were measured. Maximum concentrations were 2.9 mg/L as P and 8.5 mg/L as PO_4, respectively, for the two parameters.

5.14 Total organic carbon

Organic carbon present in all natural waters may comprise waste and decay products of living organisms, pesticides, polychlorinated biphenyls, or any of thousands of chemicals in general use. Amounts of organic compounds present in most waters are small compared with amounts of dissolved inorganics, but they can cause severe adverse effects to human health and to stream biota (Smoot, et al., 1991). Total organic carbon (TOC) is a gross measure of organic carbon used for assessment purposes.

Neither the federal government, Kentucky, Tennessee, nor Virginia has established water-quality criteria for total organic carbon. Concentrations of total organic carbon were measured on only three dates at most stations. On 3/23/93, when stream levels were so high that discharge could not safely be measured, total organic carbon levels ranged from 6.2 to 20 mg/L. On 12/5/93, at lower discharges, concentrations ranged from 1.5 to 5.4 mg/L, and they were below detection limits at all sampled stations on 13 December.

5.15 Major metals, trace elements, and inorganic compounds

Surface water contamination by metals is of concern because many metals can be toxic to aquatic organisms when present in high concentrations. Metals may enter receiving waters from such sources as runoff from rocks and soils, precipitation containing atmospheric pollutants, urban stormwater runoff, domestic and industrial wastewaters, and fertilizers. Metals are often transported in the stream by suspended sediments (Smoot, et al., 1991). Major metals, trace elements, and miscellaneous inorganic compounds which are monitored in this study include aluminum, arsenic, barium, boron, bromide, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, silicon, strontium, titanium, vanadium, and zinc.

5.15.1 Aluminum

Although aluminum is the third most abundant element in the earth's crust, it usually occurs at concentrations of less than 1 mg/L in natural waters unless the pH is below 4.0. At low pH values it can be present in sufficient amounts to be deleterious to fish (Hem, 1985). One natural source of aluminum is weathering from aluminum-bearing rocks (Hem, 1985), but it seems likely that it could also occur in low-pH leachate from landfills.

Neither Kentucky, Tennessee, Virginia, nor the federal government has established water-quality criteria for aluminum. Sample concentrations ranged from below detection limits to 0.93 mg/L for dissolved aluminum and from below detection limits to 3.3 mg/L for total aluminum. Many of the highest values at various stations did not represent typical values but were isolated peaks from a single storm event.

5.15.2 Arsenic

Small concentrations of arsenic can be toxic to humans and other organisms; therefore, it is considered highly undesirable in surface water. Arsenic is found in pesticides and is produced by the burning of coal. These may be potential sources of stream contamination (Hem, 1985). The federal government has established standards for total arsenic of 0.05 mg/L as As in drinking water. For the protection of aquatic life, federal standards are 0.36 and 0.19 mg/L total trivalent arsenic for acute and chronic exposure, respectively. Tennessee has adopted the federal standards for drinking water and for aquatic life protection. Virginia has adopted the federal drinking water standard, but not the aquatic life standards, and Kentucky has established a total arsenic criterion of 0.05 mg/L as As for warmwater aquatic habitats.

The state and federal criteria reported above are for total arsenic, but the samples were analyzed only for dissolved arsenic. It should be borne in mind that the discussion which follows is based only on the reported dissolved arsenic values.

In Kentucky, dissolved arsenic concentrations were either not reported or were below detection limits in all samples with the exception of a sample collected at YC5 on 12/5/93 after a storm event in which the concentration was 0.39 mg/L. In Tennessee and Virginia, dissolved arsenic levels in all samples were either not reported or were below detection limits.

5.15.3 Barium

Barium is considered an undesirable impurity in drinking water (Hem, 1985). According to Smoot, et al. (1991), it occurs in igneous and carbonate sedimentary rocks, and is found in low concentrations in most surface water. The proposed federal drinking water standard for total barium is 1.5 mg/L. Kentucky has established a domestic water supply criterion for total barium of 1.0 mg/L as Ba and Virginia has established a criterion of 2.0 mg/L as Ba for dissolved barium. Tennessee has not established a drinking water criterion for barium. No barium criteria have been established for the protection of aquatic life.

The Kentucky and federal criteria reported above are for total barium, but the samples were analyzed only for dissolved barium. It should be borne in mind that the discussion which follows is based only on the reported dissolved barium values.

Barium appears to have been sampled only two or three times per station, and at most stations, at least two of the samples were associated with storm events. In Kentucky, dissolved barium values ranged from below detection limits to about 0.04 mg/L. In Tennessee, they ranged

from below detection limits to 0.02 mg/L, and in Virginia, dissolved barium values generally ranged from 0.01 to 0.02 mg/L with a high of 0.20 mg/L at ST10.

5.15.4 Boron

Boron is a minor constituent of most waters, and it is essential for plant growth. One potential source is the weathering of granitic rocks and pegmatites (Hem, 1985). Neither Kentucky, Tennessee, Virginia, nor the federal government has established boron water-quality criteria. Sample values for dissolved boron ranged from below detection limits to about 0.06 mg/L

5.15.5 Bromide

Bromide is not known to have any ecological significance in small quantities. Sources of bromide include ethylene dibromide, a gasoline additive, and fumigants and fire-retardant agents (Hem, 1985). Neither Kentucky, Tennessee, Virginia, nor the federal government has established a bromide water-quality standard. Sample values for bromide were generally below detection limits; however, values of 0.4 and 0.8 mg/L were measured in samples from RR1 and YC5A, respectively.

5.15.6 Cadmium

Cadmium rarely occurs in water in other than very small amounts (Smoot, et al., 1991). Cadmium has a tendency to bioaccumulate in plants and can cause bone deterioration if the plants are consumed. Detectable concentrations are likely to be the result of contamination from the burning of fossil fuels or from leachate from industrial landfills (Hem, 1985). The federal drinking water standard for total cadmium is 0.01 mg/L with a proposed standard of 0.005 mg/L as Cd. Federal total cadmium standards for the protection of aquatic life are 0.0039 mg/L as Cd for acute exposure and 0.0011 mg/L as Cd for chronic exposure when a hardness level of 100 mg/L is used to calculate the standard. Kentucky does not have a drinking water criterion for total cadmium; however, total cadmium criteria for warmwater aquatic habitats are 0.004 mg/L as Cd for soft water and 0.012 mg/L as Cd for hard water. Tennessee has established a total cadmium criterion of 0.01 mg/L. Tennessee total cadmium criteria for the protection of aquatic life are 0.004 mg/l for a maximum concentration and 0.001 mg/L for a continuous concentration when a hardness level of 100 mg/L is used to calculate the criteria. Virginia has established a dissolved cadmium criterion for public water supplies of 0.016 mg/L and a criterion of 0.17 mg/L for all other water supplies. Virginia dissolved cadmium criteria for the protection of aquatic life are 0.0039 mg/L for acute exposure and 0.0011 mg/L for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria.

The Kentucky, Tennessee, and federal criteria reported above are for total cadmium, but the samples were analyzed only for dissolved cadmium. It should be borne in mind that the discussion which follows is based only on the reported dissolved cadmium values.

Cadmium analyses were performed on only one to three samples per station. Dissolved cadmium was below detection limits in all samples.

5.15.7 Chromium

Chromium is an essential trace element which is involved in glucose tolerance. In its hexavalent form, Cr (VI), it is also a possible carcinogen (Manahan, 1991). Concentrations of chromium in natural waters that have not been affected by waste disposal are commonly less than 0.01 mg/L (Hem, 1985). The federal drinking water standard for total chromium is 0.05 mg/L with a proposed standard of 0.12 mg/L. Federal total chromium criteria for aquatic life protection are 0.016 mg/L for Cr (VI) and 1.7 mg/L for Cr (III) for acute exposure and 0.011 mg/L for Cr (VI) and 0.21 mg/L for Cr (III) for chronic exposure when a hardness level of 100 mg/L is used to calculate the Cr (III) criteria. The Kentucky and Tennessee total chromium criteria are 0.05 mg/L as Cr for domestic water supplies and 0.10 mg/L as Cr for warmwater aquatic habitats. The Virginia total chromium criteria for public water supplies are 0.17 mg/L for Cr (VI) and 33.0 mg/L for Cr (III). For all other water supplies they are 3.4 mg/L and 670.0 mg/L, respectively. Virginia dissolved chromium criteria for the protection of aquatic life are 0.016 mg/L for Cr (VI) and 1.737 mg/L for Cr (III) for acute exposure and 0.011 mg/L for Cr (VI) and 0.207 mg/L for Cr (III) for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria.

The Kentucky, Tennessee, and federal criteria reported above are for total chromium, but the samples were analyzed only for dissolved chromium. It should be borne in mind that the discussion which follows is based only on the reported dissolved chromium values. In addition, it is assumed that all of the reported values are for hexavalent chromium, Cr (VI).

In Kentucky and Tennessee, dissolved chromium values were generally below detection limits; however, in a total of fourteen samples at six stations, dissolved chromium values ranged from 0.01 mg/L to 0.04 mg/L. These values are less than the Kentucky and Tennessee water quality criteria for total chromium. In Virginia, dissolved chromium values were below detection limits.

5.15.8 Copper

Copper is essential for plants and animals, which use it in the synthesis of chlorophyll and hemoglobin, respectively. Although it is toxic to algae, particularly in waters of low alkalinity, copper in water is not known to have an adverse effect on humans (Smoot, et al., 1991). Potential sources of copper include dissolution from copper pipes and plumbing fixtures, agricultural pesticide sprays, and algicides (Hem, 1985). The proposed federal total copper standard for drinking water is 1.3 mg/L, and the secondary standard is 1.0 mg/L. The federal total copper criteria for the protection of aquatic life are 0.018 mg/L for acute exposure and 0.012 mg/L for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria. Virginia has adopted the federal standards; however, it has applied them to dissolved copper. Kentucky has established a total copper criterion of 1.0 mg/l for domestic water supplies but has not established criteria for the protection of aquatic life. Tennessee does not have a total copper criterion for water supplies, but criteria for the protection of aquatic life are 0.018 mg/L as a maximum concentration and 0.012 mg/L as a continuous concentration when a hardness level of 100 mg/L is used to calculate the criteria.

The Kentucky, Tennessee, and federal criteria reported above are for total copper, but the samples were analyzed only for dissolved copper. It should be borne in mind that the discussion which follows is based only on the reported dissolved copper values.

In Kentucky, dissolved copper values were generally below detection limits, but ranged up to 0.02 mg/L on several occasions. These levels were well below the state drinking water criterion. In Tennessee, dissolved copper values were generally below detection limits, but in three samples from Gap Creek stations, they reached values of 0.02 to 0.04 mg/L. These values are higher than the Tennessee maximum and continuous concentration criteria for the protection of aquatic life, but the criteria are based on a hardness level of 100 mg/l. No attempt was made to recalculate the criteria to take into account the hardness level in the samples. In Virginia, dissolved copper concentrations in all samples were below detection limits.

5.15.9 Iron

Iron is an essential element in the metabolisms of plants and animals. If present in excess in water, however, it forms precipitates which stain laundry and plumbing fixtures (Hem, 1985). In addition, ferric hydroxide flocs may coat fish gills, and the precipitates may smother fish eggs and bottom-dwelling organisms. Coal mining exposes iron-bearing minerals associated with the coal; thus, mine drainage is a major source of iron in surface waters (Smoot, et al., 1991). The federal drinking water standard for total iron is 0.3 mg/L, and the chronic exposure standard for the protection of aquatic life is 1.0 mg/L as Fe. Kentucky has not established a drinking water criterion for total iron, but it has adopted the federal total iron standard for the protection of aquatic life. Virginia has adopted the federal drinking water standard for total iron; however, it has applied the standard to dissolved iron. Virginia has not established iron standards for the protection of aquatic life. Tennessee has not established any water-quality criteria for iron.

In Kentucky, total iron concentrations generally were less than the 1.0 mg/L criterion for the protection of aquatic life at all stations except DB5, where the criterion was exceeded in 40 percent of samples. A few isolated exceedances ranging from 1.1 to 3.5 mg/L also occurred at other stations (Figure 11). Dissolved iron concentrations in Kentucky ranged from below detection limits to 1.1 mg/L. In Tennessee, total iron concentrations in samples ranged from below detection limits to 1.5 mg/L, and dissolved iron concentrations ranged from below detection limits to 0.41 mg/L. In Virginia, total iron concentrations ranged from 0.09 to 1.3 mg/L, and dissolved iron concentrations ranged from 0.03 to 0.26 mg/L.

5.15.10 Lead

Acute lead poisoning in humans causes severe dysfunction in the kidneys, reproductive system, liver, and the brain and central nervous system. Mild lead poisoning causes anemia (Manahan, 1991). Lead has been dispersed throughout the environment by the use of leaded gasoline. Large amounts of lead can also be released by the burning of coal (Smoot, 1991).The

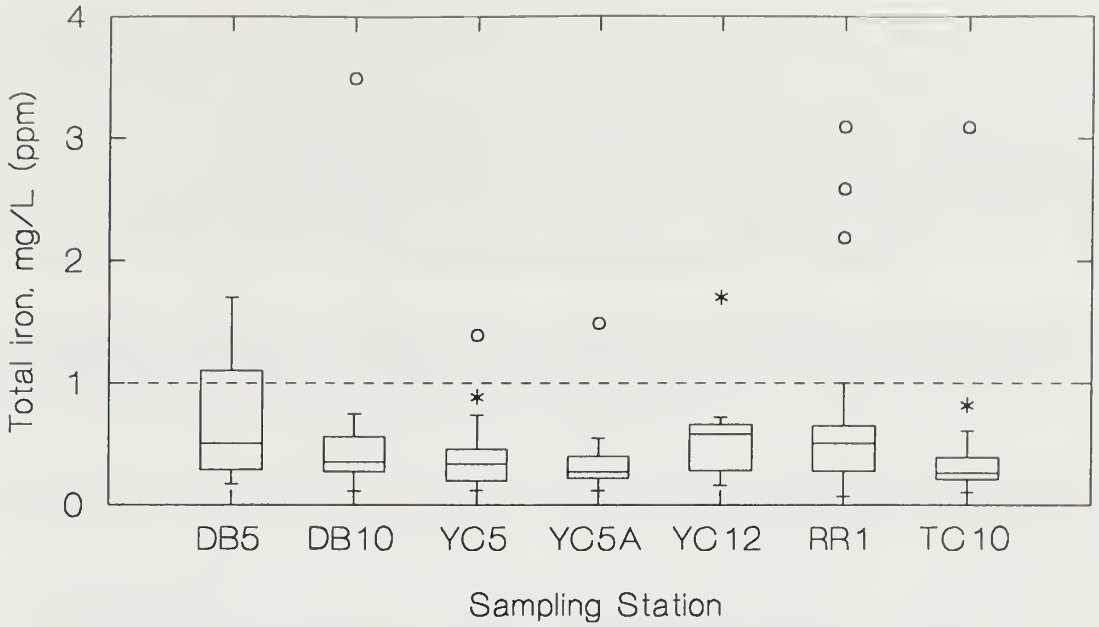

Figure 11. Total iron distribution at Kentucky stations - 1993
(Dotted line represents state criterion)
(See Appendix G for explanation of boxplot)

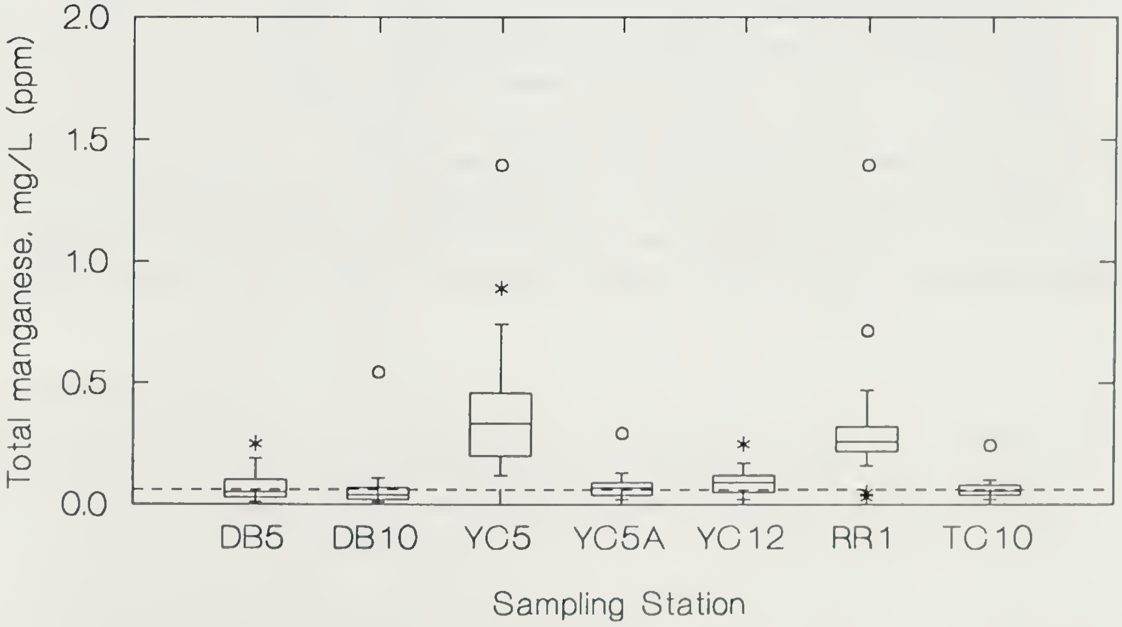

Figure 12. Total manganese distribution at Kentucky stations - 1993
(Dotted line represents state criterion)
(See Appendix G for explanation of boxplot)

federal drinking water standard for total lead is 0.05 mg/L with a proposed standard of 0.005 mg/L. The federal total lead criteria for the protection of aquatic life are 0.082 mg/L as Pb for acute exposure and 0.0032 mg/L for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria. Kentucky has adopted the federal total lead standard for drinking water but has not established total lead criteria for the protection of aquatic life. Tennessee and Virginia have adopted the federal total lead criteria for the protection of aquatic life as well as the federal total lead drinking water standard, but Virginia has applied them to dissolved lead.

The Kentucky, Tennessee, and federal criteria reported above are for total lead, but the samples were analyzed only for dissolved lead. It should be borne in mind that the discussion which follows is based only on the reported dissolved lead values.

Dissolved lead values were below detection limits in all but one sample collected after a storm event on 3/23/93 at YC5.

5.15.11 Manganese

Manganese is an essential element for both plants and animals; however, it is an undesirable impurity in water supplies chiefly because of its deposition of black oxide stains (Hem, 1985). Sources of manganese in water include the weathering of manganese-bearing rocks (Hem 1985), and drainage from coal mines (Smoot, et al., 1991). The federal drinking water standard for total manganese of 0.05 mg/L has been adopted by Kentucky, Tennessee, and Virginia, but Virginia has applied it to dissolved manganese. No manganese criteria for the protection of aquatic life have been established.

In Kentucky, total manganese concentrations often exceeded drinking water criteria at all stations, in particular, YC5 and RR1. Total manganese values generally ranged from below detection limits to about 0.55 mg/L, but higher values occurred in some samples (Figure 12). Dissolved manganese values ranged from below detection limits to 0.61 mg/L. In Tennessee, total manganese values generally ranged from below detection limits to about 0.09 mg/L with occasional higher values ranging up to 0.27 mg/L (TD1). Dissolved manganese values generally ranged from below detection limits to about 0.07 mg/l . In Virginia, total manganese levels generally ranged from below detection limits to 0.03 mg/l with high values of 0.27 and 0.40 mg/L at LH5 and ST10, respectively. Dissolved manganese values ranged from below detection limits to 0.03 mg/L.

5.15.12 Mercury

Mercury generates the most concern of any of the heavy-metal pollutants. Among the toxicological effects of mercury are neurological damage, chromosome breakage, and birth defects. Mercury enters the environment from a large number of sources such as discarded laboratory chemicals, broken thermometers, dry-cell batteries, fungicides, and pharmaceutical products. Sewage effluent sometimes contains up to ten times the amount of mercury found in typical natural waters (Manahan, 1991). The federal drinking water standard for total mercury is 0.002 mg/L, and federal total mercury criteria for the protection of aquatic life are 0.0024 mg/L

for acute exposure and 0.000012 mg/L (0.12 μg/L) for chronic exposure. Kentucky has established a total mercury criterion of 0.0002 mg/L for the protection of aquatic life but has not established a total mercury criterion for domestic water supplies. Tennessee has adopted federal total mercury standards for drinking water and for the protection of aquatic life. Virginia has adopted federal total mercury standards for the protection of aquatic life, but it has applied them to dissolved mercury. It has established dissolved mercury standards of 0.7 mg/L for public water supplies and 215.0 mg/L for all other water supplies.

The Kentucky, Tennessee, and federal criteria reported above are for total mercury, but the samples were analyzed only for dissolved mercury. It should be borne in mind that the discussion which follows is based only on the reported dissolved mercury values.

In Kentucky and Tennessee, only one or two samples were analyzed for dissolved mercury at each station. Samples collected in association with a storm event contained 0.83 to 1.13 mg/L of dissolved mercury, but samples which were not associated with a storm event contained concentrations below the detection limits. In Virginia, only one sample from each station was analyzed for dissolved mercury. The samples were associated with storm events and contained 0.58 to 1.1 mg/L of dissolved mercury.

5.15.13 Molybdenum

Molybdenum is a fairly rare element which is essential in animal and plant nutrition (Hem, 1985). The most common environmental source of molybdenum is the burning of fossil fuels (Smoot, et al, 1991). Neither Kentucky, Tennessee, Virginia, nor the federal government has established water criteria for molybdenum.

Only one or two samples from each station were analyzed for molybdenum. Dissolved molybdenum levels were below detection limits in all samples.

5.15.14 Nickel

Nickel, while relatively nontoxic to man, is toxic to a broad range of aquatic plants and animals. Its effects vary according to species, pH and synergistic effects. Nickel is a widely used industrial metal, and the improper disposal of industrial wastes can be a major source of nickel contamination (Hem, 1985). The federal government has not established drinking water standards for nickel. Federal total nickel water-quality criteria for the protection of aquatic life are 1.8 mg/L as Ni for acute exposure and 0.096 mg/L as Ni for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria. Kentucky has not established water-quality criteria for nickel. Tennessee has not established total nickel criteria for domestic water supplies, but its total nickel criteria for the protection of aquatic life are 1.4 mg/L as a maximum concentration and 0.16 mg/L as a continuous concentration when a hardness level of 100 mg/L is used to calculate the criteria. Virginia has established dissolved nickel criteria of 0.61 mg/L public water supplies and 4.58 mg/L for all other water supplies. The Virginia dissolved nickel criteria for the protection of aquatic life are 1.42 mg/L for acute exposure and 0.16 mg/L for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria.

The Kentucky, Tennessee, and federal criteria reported above are for total nickel, but the samples were analyzed only for dissolved nickel. It should be borne in mind that the discussion which follows is based on the reported dissolved nickel values.

In Kentucky, dissolved nickel concentrations were generally below detection limits, although several samples contained levels of 0.01 or 0.02 mg/L. Dissolved nickel levels of 0.2 and 2.6 mg/L were measured in two samples from SH10 and TC10, respectively. In Tennessee, dissolved nickel concentrations were generally below detection limits, although concentrations ranged from 0.01 to 0.02 mg/L in six samples. In Virginia, only two to three samples were collected at each station. Dissolved nickel concentrations in the samples were below detection limits.

5.15.15 Silicon

Silicon is the second most common element in the earth's crust after oxygen. In natural waters, it occurs as silica (SiO_2) (Hem, 1985). Silicosis is a common occupational disease resulting from human exposure to silica dust (Manahan, 1991), but apparently silica has no health or ecological effects in aqueous solution. Neither Kentucky, Tennessee, Virginia nor the federal government has established water-quality criteria for silica.

Sample values for dissolved silicon generally ranged from 1.3 to 5.9 mg/L. In two cases, however, dissolved silicon values were below the detection limit, and in one sample from DB10, a value of 12.0 mg/L was reported.

5.15.16 Strontium

Strontium chemistry is similar to that of calcium. Although it is interchangeable with calcium in bone (Manahan, 1991), it is usually not a water-quality concern unless its radioactive isotope, ^{90}Sr, a product of atomic fission, is present (Hem, 1985). Neither Kentucky, Tennessee, Virginia, nor the federal government has established water-quality criteria for strontium.

Analyses for dissolved strontium were performed only on samples collected on 2/23/93 in association with a storm event. Dissolved strontium values ranged from below detection limits to 0.14 mg/L.

5.15.17 Titanium

Titanium is an abundant element in crustal rocks, but is usually present in natural waters only at very low levels (Hem, 1985). No references were encountered regarding any health or ecology-related effects of titanium in aquatic systems. Neither Kentucky, Tennessee, Virginia, nor the federal government has established water-quality criteria for titanium.

Sample values for dissolved titanium for the most part were below the detection limit. In eight samples, however, they ranged from 0.01 to 0.10 mg/L, and in 6 samples, dissolved titanium values ranged from 3.0 to 9.8 mg/L.

5.15.18 Vanadium

Vanadium is involved in biochemical processes in living matter. It is present in coal and petroleum and may be released to the environment when those fuels are burned (Hem, 1985). Little is known of the effects of vanadium on aquatic organisms; however, it accumulates in certain animal organs (Smoot, et al., 1991). Neither Kentucky, Tennessee, Virginia, nor the federal government has established water-quality criteria for vanadium.

Sample values for dissolved vanadium were generally below the detection limit; however, values from seven samples ranged from 0.01 to 0.07 mg/L.

5.15.19 Zinc

Zinc is essential in plant and animal enzyme metabolism, and it aids wound healing. It is toxic to plants at higher levels (Manahan, 1991). At concentrations greater than 5 mg/L, a significant number of people can detect zinc by taste, but no health effects are considered likely (Hem, 1985). Zinc is a major component of sewage sludge (Manahan, 1991) which if improperly disposed of could provide a potential source of zinc. Other potential sources are runoff from mining areas and industrial and urban wastes from galvanized pipes (Smoot, et al., 1991). The federal drinking water standard for total zinc is 5.0 mg/L, and the federal total zinc criteria for the protection of aquatic life are 0.32 mg/L as Zn for acute exposure and 0.047 mg/L as Zn for chronic exposure when a hardness level of 100 mg/L is used to calculate the criteria. Kentucky has not established a zinc criterion for domestic water supplies, but it has adopted the federal total zinc criterion of 0.047 mg/L for the protection of aquatic life. Tennessee has not established a zinc criterion for domestic water supplies, but it has established total zinc criteria for the protection of aquatic life of 0.117 mg/L as a maximum concentration and 0.106 mg/L as a continuous concentration when a hardness level of 100 mg/L is used to calculate the criteria. Virginia has adopted the federal total zinc drinking water standard for public water supplies, and its zinc standards for the protection of aquatic life are identical to those of Tennessee; however, Virginia standards apply to dissolved, rather than total, zinc.

The Kentucky, Tennessee, and federal criteria reported above are for total zinc, but the samples were analyzed only for dissolved zinc. It should be borne in mind that the discussion which follows is based only on the reported dissolved zinc values.

In Kentucky, dissolved zinc values generally ranged from below the detection limit to 0.04 mg/L, but at TC10, RR1, and YC5, values from 0.5 to 0.6 mg/L were measured which are above the Kentucky criteria for the protection of aquatic life if 100 mg/L of hardness is assumed. Even higher values of 4.2 and 4.5 mg/L for dissolved zinc were measured in two samples from DB5 and SH10, respectively. In Tennessee, dissolved zinc values ranged from below the detection limit to 0.05 mg/L. The values are below the Tennessee criteria for total zinc when 100 mg/L hardness is assumed. In Virginia, dissolved zinc values ranged from below the detection limit to 0.02 mg/L. These values are below the Virginia criteria for dissolved zinc when 100 mg/L of hardness is assumed. No attempt was made to recalculate criteria to take into account the hardness levels in the samples.

Table 8. Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments Established by the U. S. Environmental Protection Agency, Region V. (1977)

Parameter	Nonpolluted	Moderately Polluted	Heavily Polluted
Ammonia (mg/kg dry wt.)	< 75	75 - 200	> 200
Arsenic (mg/kg dry wt.)	< 3	3 - 8	> 8
Barium (mg/kg dry wt.)	< 20	20 - 60	> 60
Cadmium (mg/kg dry wt.)	*	*	*
Chromium (mg/kg dry wt.)	< 25	25 - 75	> 75
COD (mg/kg dry wt.)	< 40,000	50,000 - 80,000	> 80,000
Copper (mg/kg dry wt.)	< 25	25 - 50	> 50
Cyanide (mg/kg dry wt.)	< 0.10	0.10 - 0.25	> 0.25
Iron (mg/kg dry wt.)	< 17,000	17,000 - 25,000	> 25,000
Lead (mg/kg dry wt.)	< 40	40 - 60	> 60
Manganese (mg/kg dry wt.)	< 300	300 - 500	> 500
Mercury (mg/kg dry wt.)	*	1	> 1
Nickel (mg/kg dry wt.)	< 20	20 - 50	> 50
Oil & Grease (Hexane solubles, mg/kg dry wt.)	< 1,000	1,000 - 2,000	> 2,000
Phosphorous (mg/kg dry wt.)	< 420	420 - 650	> 650
TKN mg/kg dry wt.)	< 1,000	1,000 - 2,000	> 2,000
Total PCBs (mg/kg dry wt.)	*	10	> 10
Volatile Solids (%)	< 5	5 - 8	> 8
Zinc (mg/kg dry wt.)	< 90	90 - 200	> 200

* Limits not established

5.16 Oil and grease

Oil and grease analyses are used to determine whether waters are being contaminated with petroleum products. Sources relevant to this study would include leaks and spills of fuels or motor oils required for construction machinery.

In Kentucky waters, oil and grease values were below the detection limit at DB5 but ranged from 0.05 to 3.0 mg/L at DB10. AT RR1, oil and grease values ranged from 0.03 to 0.6 mg/L, and at TC10 they ranged from below the detection limit to 6.0 mg/L. In Little Yellow Creek, oil and grease values were below the detection limit at YC5 and YC12, but they ranged from below the detection limit to 2.0 mg/L at YC5A, which is a short distance downstream from the mouth of Tunnel Creek. In Tennessee waters, Oil and grease values were below the detection limit at GC3, but ranged from below the detection limit to 3.4 mg/L and 1.5 mg/L at GC4 and GC7, respectively. Oil and grease values ranged from below the detection limit to 4.0 mg/L at TD1. In Virginia waters, oil and grease values were generally not reported .

6. Streambed-sediment chemistry - 1993

6.1 Sediment parameters and criteria

In the CUGA water monitoring program, a total of 40 constituents and physical properties are reported for sediment samples rather than the 55 that are reported for some water samples (Table 7). Because no federal or state criteria for streambed pollutants are known to exist (Nodvin and Rhodes, 1994), this report follows the practice established in previous reports (Nodvin and Rhodes, 1993b, 1994; Moore and Smoot, 1993) of applying the harbor pollution guidelines developed for great lakes harbor sediments (U. S. EPA, 1977) as pollution guidelines for the streambed sediment samples collected during this study (Table 8). Only 12 of the 40 sediment parameters measured in this study are included among the 19 pollutants for which guidelines are listed in Table 8.

6.2 Sediment sampling methods

Sediment samples are collected quarterly from selected stations by means of a stainless steel spoon and bucket. They are composited from at least three areas at a site, and bankside deposits are avoided. Samples are stored in pre-cleaned borosilicate glass freezer jars with teflon-lined lids (Nodvin and Rhodes, 1993a).

6.3 Analytical results - constituents

6.3.1 Aluminum

Aluminum concentrations in sediment samples ranged from 0.2 to 183.0 mg/kg for Davis Branch, 2.3 to 494.0 mg/kg for Gap Creek, 11.6 to 589.0 mg/kg for Tunnel Creek, and 0.6 to 299.0 mg/kg for Little Yellow Creek. Concentrations in samples from other streams ranged from 3.1 to 512.0 mg/kg. No guidelines for aluminum are included in Table 8.

6.3.2 Arsenic

Arsenic concentrations were below detection limits in all samples. These sediments can be classified as nonpolluted with regard to arsenic according to the guidelines of Table 8.

6.3.3 Barium

With regard to barium, sediment samples from Tunnel Creek and Little Yellow Creek were nonpolluted, with barium concentrations of less than 20 mg/kg. Samples from Gap Creek , Davis Branch, Lewis Hollow, Station Creek, and Sugar Run, were nonpolluted to moderately polluted, with barium concentrations ranging from 9.4 to 55.5 mg/kg. Moderate to heavy pollution was measured in three samples from TD1, with barium concentrations ranging from 46.2 to 94.8 mg/kg although the barium concentration in a fourth sample was less than 1.0 mg/kg.

6.3.4 Boron

Boron concentrations in sediment samples ranged from 0.1 to 2.8 mg/kg for Davis Branch, 0.14 to 3.31 mg/kg for Gap Creek, 0.12 to 2.20 mg/kg for Tunnel Creek, and 0.02 to 3.6 mg/kg for Little Yellow Creek. Concentrations in samples from other streams ranged from below detection limits to 3.4 mg/kg. No guidelines for boron are included in Table 8.

6.3.5 Bromine

Bromine concentrations in sediment samples were below the detection limit in all but two samples. Concentrations of 0.5 and 7.0 mg/kg were measured in samples from TC10 and TD1, respectively. No guidelines for bromine are included in Table 8.

6.3.6 Cadmium

Cadmium concentrations were below the detection limit in sediment samples from Davis Branch, Little Yellow Creek, and Sugar Run. In Gap Creek, Station Creek, and Lewis Hollow samples, they ranged from below the detection limit to 0.30 mg/kg. In sediment samples from TD1, cadmium concentrations ranged from below the detection limit to 0.95 mg/kg. Although cadmium is listed as a parameter in Table 8, no guidelines are provided, since limits have not been established.

6.3.7 Calcium

Calcium concentrations in sediment samples ranged from 5 to 4020 mg/kg for Davis Branch, 59 to 12,600 mg/kg for Gap Creek, 71 to 19,299 mg/kg for Tunnel Creek, 3 to 4760 mg/kg for Little Yellow Creek, 9 to 15,500 for Station Creek, 130 to 17,900 at TD1, 12 to 1140 for Lewis Hollow, and a calcium concentration of 7,820 was measured in one sample from Sugar Run. No guidelines for calcium are included in Table 8.

6.3.8 Carbon, total

Total carbon concentrations in all sediment samples ranged from 3.2 to 37.0 mg/kg. No guidelines for total carbon are listed in Table 8.

6.3.9 Carbon, total organic

Total organic carbon concentrations in all sediment samples ranged from below the detection limit to 94.0 mg/kg. No guidelines for total organic carbon are listed in Table 8.

6.3.10 Chloride

Chloride concentrations in most sediment samples ranged from 0.6 mg/kg to 61.o mg/kg; however, a chloride concentration of 630.0 mg/kg was measured in a sample collected at YC5 on 1/23/93. No guidelines for chloride are listed in Table 8.

6.3.11 Chromium

Chromium values in most sediment samples ranged from below the detection limit to 0.2 mg/kg; however, values of 1.5, 6.3, and 11.0 mg/kg were measured in samples from TD1, TC10, and YC5A, respectively. All of the samples contained chromium concentrations of less than 25 mg/l; therefore, they are classified as "nonpolluted" with regard to chromium according to the guidelines of Table 8.

6.3.12 Cobalt

Cobalt concentrations in sediment samples ranged from below the detection limit to 3.7 mg/kg. No guidelines for cobalt are listed in Table 8.

6.3.13 Copper

Copper concentrations in sediment generally ranged from below the detection limit to 5.82 mg/kg; however, a concentration of 16.0 mg/kg was measured in a sample collected at TD1 on 7/6/93. All of the samples contained copper concentrations of less than 25 mg/kg; therefore, they are classified as "nonpolluted" with regard to copper according to the guidelines of Table 8.

6.3.14 Fluoride

Fluoride concentrations ranged from below the detection limit to 9.0 mg/kg in samples from Davis Branch and Lewis Hollow. In other samples, they ranged from below the detection limit to 90.4 mg/kg. No guidelines for fluoride are listed in Table 8.

6.3.15 Germanium

Germanium concentrations were below the detection limit in all sediment samples. No guidelines for germanium are listed in Table 8.

6.3.16 Iron

Iron concentrations in sediment samples ranged form below the detection limit to 878.0 mg/kg. All of the samples contained iron concentrations of less than 17,000 mg/kg; therefore, they are classified as "nonpolluted" with regard to iron according to the guidelines of Table 8.

6.3.17 Lead

Lead concentrations in sediment samples ranged from below the detection limit to 12.0 mg/kg. All of the samples contained lead concentrations of less than 40 mg/kg; therefore, they are classified as "nonpolluted" with regard to lead according to the guidelines of Table 8.

6.3.18 Lithium

Lithium concentrations were below the detection limit in all sediment samples. No lithium guidelines are listed in Table 8.

6.3.19 Magnesium

Magnesium concentrations in sediment samples generally ranged from about 0.5 to 920 mg/kg; however, a concentration of 4,900 mg/kg was measured in a sample from TD1 that was collected on 10/19/93. No magnesium guidelines are listed in Table 8.

6.3.20 Manganese

Manganese concentrations in sediment samples generally ranged from 2.4 to 289 mg/kg. Thus, since they contained manganese concentrations of less than 300 mg/kg, these samples would be classified as "nonpolluted" with regard to manganese according to the guidelines in Table 8. One sample collected at TD1 on 10/19/93 contained a manganese concentration of 361 mg/kg; it would therefore be classified as "moderately polluted" with regard to manganese.

6.3.21 Mercury

Mercury concentrations were below the detection limit in all sediment samples. No guideline has been established below which a sediment would be considered "nonpolluted" with regard to mercury (Table 8); however, all of the sample concentrations were lower than the 1 mg/kg guideline for "moderately polluted" sediments.

6.3.22 Molybdenum

Molybdenum concentrations were below the detection limit in all sediment samples. No molybdenum guidelines are listed in Table 8.

6.3.23 Nickel

Nickel concentrations in all sediment samples ranged from below the detection limit to 3.80 mg/kg. Thus, since they contained nickel concentrations of less than 20 mg/kg, they would be classified as "nonpolluted" with regard to nickel according to the guidelines in Table 8.

6.3.24 Nitrate

Nitrate concentrations in sediment samples ranged from below the detection limit to 55.0 mg/kg. No nitrate guidelines are listed in Table 8.

6.3.25 Nitrite

Nitrite concentrations in sediment samples ranged from below the detection to 16.0 mg/kg. No nitrite guidelines are listed in Table 8.

6.3.26 Orthophosphate

Orthophosphate concentrations in sediment samples were below the detection limit. No orthophosphate guidelines are listed in Table 8.

6.3.27 Phosphorous

Phosphorous concentrations in sediment samples ranged from below the detection limit to 50.0 mg/kg . All of the samples contained less than 420 mg/kg of phosphorous; therefore, they would be classified as "nonpolluted" with regard to phosphorous, according to the guidelines in Table 8.

6.3.28 Potassium

Potassium concentrations in sediment samples ranged from below the detection limit to 120.0 mg/kg. No potassium guidelines are listed in Table 8.

6.3.29 Silicon

Silicon concentrations in sediment samples ranged from below the detection limit to 830.0 mg/kg. No silicon guidelines are listed in Table 8

6.3.30 Sodium

Sodium concentrations in sediment samples ranged from below the detection limit to 55.0 mg/kg. No sodium guidelines are listed in Table 8.

6.3.31 Strontium

Strontium concentrations in sediment samples ranged from below the detection limit to 22.0 mg/kg. No strontium guidelines are listed in Table 8.

6.3.32 Sulfate

Sulfate concentrations in sediment samples generally ranged from below the detection limit to 310.0 mg/kg; however, a sulfate concentration of 1,100.0 mg/kg was measured in a sample from TC10 that was collected on 6/1/93. No sulfate guidelines are listed in Table 8.

6.3.33 Sulfur, total

Total sulfur concentrations were quite low in sediment samples collected on 1/26/93 and 6/1/93, ranging from below the detection limit to 0.34 mg/kg; however, concentrations in samples collected on 7/6/93 ranged from 154.0 to 1,930.0 mg/kg. The SR10 sample collected on 7/6/93, in which the total sulfur concentration was below the detection limit, was the exception to the pattern. No total sulfur guidelines are listed in Table 8.

6.3.34 Titanium

Titanium concentrations in sediment samples ranged from below the detection limit to 6.5 mg/kg. No titanium guidelines are listed in Table 8.

6.3.35 Vanadium

Vanadium concentrations in sediment samples were below detection limits in all but one sample. A vanadium concentration of 2.2 mg/kg was measured in a sample collected at YC5A on 10/19/93. No vanadium guidelines are listed in Table 8.

6.3.36 Zinc

Zinc concentrations in sediment samples ranged from below the detection limit to 39.8 mg/kg. All of the samples contained zinc concentrations of less than 90 mg/kg; therefore, they are classified as "nonpolluted" with regard to zinc according to the guidelines of Table 8.

6.4 Analytical results - properties

6.4.1 Acidity, potential

Potential acidity is a calculated quantity which is based on a sample's total sulfur content. It is calculated according to the formula: Potential acidity = % total sulfur in sample x 31.25, and it is reported in terms of calcium carbonate (Harwood, 1994. Personal communication). Potential acidity in sediment samples ranged from below the detection limit to 11.0 mg/kg. No potential acidity guidelines are listed in Table 8.

6.4.2 Acid-base account, net

The net acid-base account is calculated as the difference between the neutralization potential and the potential acidity (Harwood, 1994. Personal communication). Reported values ranged from 1.1 to 300.0 mg/kg although some of the values were incorrectly calculated as sums, rather than as differences. No net acid-base account guidelines are listed in Table 8.

6.4.3 Neutralization potential

The neutralization potential is a measure of the alkalinity of a solid sample. It is reported in terms of calcium carbonate (Harwood, 1994. Personal communication). Neutralization potential values in sediment samples ranged from 1.15 to 297.0 mg/kg. No neutralization potential guidelines are listed in Table 8.

6.4.4 Paste pH

Paste pH is the pH value of a slurry formed from a solid sample (Harwood, 1994. Personal communication). Paste pH values of sediment samples ranged from 4.6 to 8.6. No paste pH guidelines are listed in Table 8.

7.0 Recommendations

7.1 Introduction

Generally, a parameter (a particular constituent or property of a water or sediment) should be included in a monitoring program when its excess or deficiency could adversely affect aquatic

biota, other users of the water, or esthetics, or when knowledge of its magnitude would aid in predicting the possible effects of other parameters. If a parameter does not meet these criteria, it might be wise to consider deleting it from the monitoring program, since its inclusion might fail to advance the purposes of the program, be economically unjustified, or be a source of potential confusion and unnecessary labor when interpreting data or preparing reports.

Many of the most important water-quality parameters are listed by the federal and state governments with accompanying criteria for each for the protection of aquatic life, human health, and recreation. The criteria become enforceable standards when applied to a particular water and the parameters to which they refer should, therefore, be included in any monitoring program involving that water. Some parameters which may have been perceived by government to carry lower risk and for which no water quality criteria exist may still be included in a particular monitoring program for the sake of completeness or to avoid potential liability. Others may be included in order to monitor project-specific activities or conditions, and in some cases, it might be desirable to monitor a parameter of minor significance long enough to establish the range of concentrations over which it is normally present. The following sections suggest parameters that for the reasons described above might possibly be considered for addition to or deletion from the CUGA water monitoring program. Other possible changes are suggested relevant to the analyses performed and the way the parameters are presently reported.

7.2 Water quality

Consideration should be given to deleting the following from analyses performed on water samples:

Boron:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained
Bromide	no established criteria, adverse effects unlikely, limited pollution indicator, sufficient baseline data obtained
Carbonate:	no established criteria, adverse effects unlikely, appreciable amounts present only at pH>10
Fluoride:	criteria and adverse effects only for drinking water, poor pollution indicator, sufficient baseline data obtained
Molybdenum:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained
Orthophosphate:	no established criteria, adverse effects unlikely, sufficient baseline data obtained
Potassium:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained
Silicon:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained
Strontium:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained

Titanium:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained
Vanadium:	no established criteria, adverse effects unlikely, poor pollution indicator, sufficient baseline data obtained

Recommended additions to the program are as follows:

Ammonia, total:	listed in federal and Kentucky water-quality criteria
Antimony:	listed in Tennessee water-quality criteria
Beryllium:	listed in Kentucky and Tennessee water-quality criteria
Cyanide:	listed in federal, Kentucky, Virginia, and Tennessee water-quality criteria
Phosphorous, total:	listed in Virginia water-quality criteria
Selenium:	listed in federal, Kentucky, Tennessee, and Virginia water-quality criteria
Silver:	listed in federal, Kentucky, Tennessee, and Virginia water-quality criteria

It is also evident that for most of the metals, only dissolved values are reported, whereas federal, Kentucky, and Tennessee criteria are based upon values for the total metals. Only Virginia criteria are based upon dissolved values. It is recommended that a decision be made to report both total and dissolved values or, since most of the active areas of the project are in Kentucky and Tennessee, to report total values only.

7.3 Sediments

Consideration should be given to deleting the following from analyses performed on sediment samples:

Boron:	recommended for deletion from water analyses
Bromide:	recommended for deletion from water analyses
Cobalt:	no guidelines established, adverse effects unlikely, poor pollution indicator
Fluoride:	recommended for deletion from water analyses
Germanium:	no guidelines established, not included in water analyses, sufficient baseline data obtained

Molybdenum:	recommended for deletion from water analyses
Orthophosphate:	recommended for deletion from water analysis
Potassium:	recommended for deletion from water analyses
Silicon:	recommended for deletion from water analyses
Strontium:	recommended for deletion from water analyses
Titanium:	recommended for deletion from water analyses
Vanadium:	recommended for deletion from water analyses

Consideration should be given to adding the following to the analyses performed on sediment samples:

Ammonia:	guidelines established, recommended for addition to water analyses
Cyanide:	guidelines established, recommended for addition to water analyses

8.0 Trend analysis

8.1 Introduction

Historically, human-related sources of degradation to the water quality of the streams being monitored are likely to have included, among others, timbering, mining, road construction, urban runoff, and leachate from septic systems. Due to the scarcity of historical data, it is difficult to determine whether the changes reached an equilibrium level at some time in the past or whether they are continuing. Information that would help to answer this question could be important in interpreting the findings of the present study. If stream water quality was at equilibrium when construction began on the tunnel, then observed changes might well be attributed to construction activities. On the other hand, ongoing historical water quality trends could be erroneously perceived as resulting from recent construction activities, thus raising needless concerns about the impact of construction on park streams.

8.2 Evaluation of historical trends-Davis Branch and Little Yellow Creek

A search was made of the U. S. EPA's STORET database, which contains sampling sites and their associated quality data, to determine whether it contained information regarding any of the watersheds in the park. Only two entries were found. They contained water quality data that had been collected in the vicinity of Middlesboro, Kentucky, on Little Yellow Creek and Davis Branch, from 5/27/64 through 9/22/64 (Appendix E). The mean values of several parameters

represented in the 1964 data (Table 9) were compared to the distributions of measured concentrations of the same parameters from samples collected at YC5 and DB10 in 1993. These stations were chosen to represent streams or stream reaches that have not been disturbed by recent construction activities. The distributions are represented by Tukey box plots, which are explained in Appendix G.

The differences between the 1964 and 1993 data do not appear to be very great. This suggests that present water quality in areas of Little Yellow Creek upstream from TC10 and in Davis Branch is reasonably close to that of 30 years ago. Although the 1964 manganese concentrations were found to be far upper outliers to the 1993 distributions of manganese concentrations in both streams (Figure 13), 1964 levels of most other parameters are within the interquartile ranges or outer adjacent values or are outliers of 1993 distributions. The 1964 total alkalinity concentrations are within the 1993 range, although in Davis Branch, the 1964 value lies slightly outside the 1993 interquartile range (Figure 14). In Davis Branch, the 1964 chloride value is slightly less than the upper adjacent value of the 1993 distribution, but in Little Yellow Creek, it is an outlier of a very narrow chloride distribution (Figure 15). The 1964 conductivity value is just outside the upper hinge of the 1993 interquartile range in Davis Branch, and it is below the median but within the interquartile range in Little Yellow Creek (Figure 16). The 1964 concentrations of total iron lie within the lower half of the 1993 interquartile range in both the Davis Branch and the Little Yellow Creek distributions (Figure 17). The 1964 sulfate concentration is within the upper adjacent value of the 1993 Davis Branch distribution, but it appears to be positioned as an outlier to the relatively narrow 1993 sulfate distribution in Little Yellow Creek (Figure 18). The 1964 pH value is very close to the median value of the 1993 Davis Branch distribution, but it is located not far above the lower adjacent value of the Little Yellow Creek distribution (Figure 19). The 1964 concentration of HCO_3^- is positioned as a far upper outlier to the 1993 Davis Branch distribution, but it lies near the median of the relatively narrow 1993 distribution of HCO_3^- concentrations in Little Yellow Creek (Figure 20).

8.3 Evaluation of recent trends - Tunnel Creek, Davis Branch and Little Yellow Creek

The importance, as well as the occurrence, of contamination events are often not recognized until their effects upon the stream's aquatic biota become evident. It was for this reason that a program of quarterly sampling of benthic macroinvertebrates was initiated in conjunction with the CUGA water monitoring program. The results of the program through 5/93 are presented in Skelton and Eisenhour (1993). A summary of the results is contained in Appendix D

A review of data from TC10 in Tunnel Creek suggests that sedimentation and/or pH fluctuations have had a catastrophic impact on the abundance of benthos in that stream. Figure 21 shows that from 7/91 through 12/91, discharges of water with pH near 4.0 and suspended sediment loads of up to 615 mg/L were measured at TC10. The affect on benthic organisms is evident in Figure 22. The number of specimens declined from an average of 57 per sample prior to 8/91 to an average of about 2 per sample after 9/91.

Table 9. Mean values of selected 1964 water quality parameters [1]

Parameter	Davis Branch	Little Yellow Creek
Alkalinity, total (mg/L)	91.5	10.0
Chloride (mg/L)	17.5	1.7
Conductivity (μg/L)	270.0	30.7
HCO_3^- (mg/L)	112.0	12.0
Iron, total (μg/L)	320.0	240.0
Manganese (μg/L)	215.0	583.0
pH (S.U.)	7.4	6.5
Sulfate (mg/L)	23.0	5.1

[1] From U, S. EPA STORET database (Appendix E)

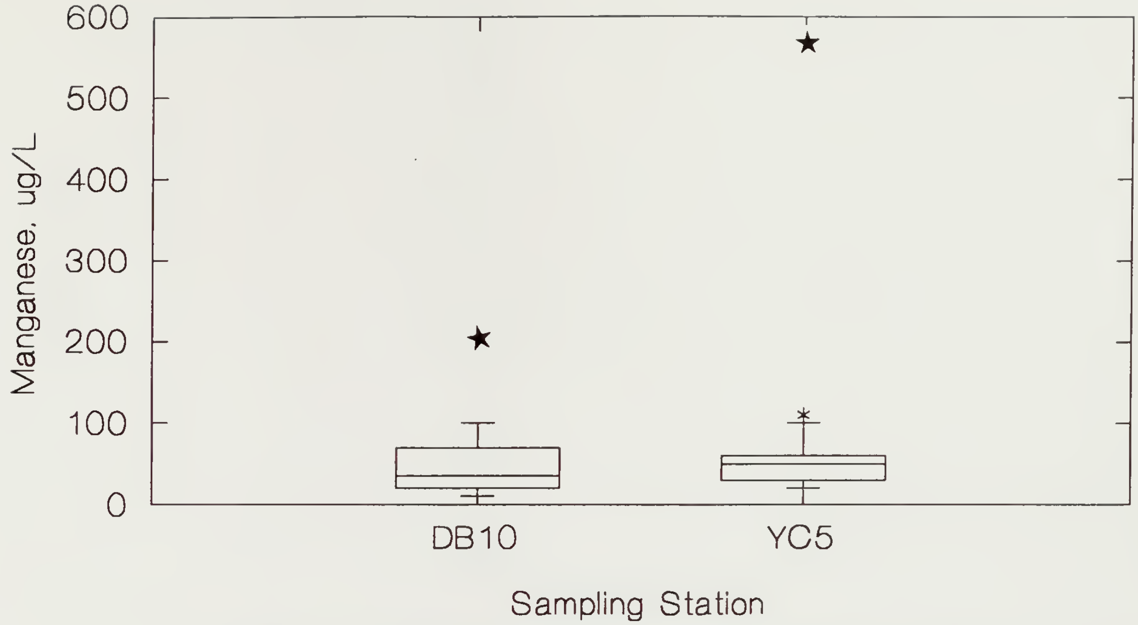

Figure 13. Dissolved manganese distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

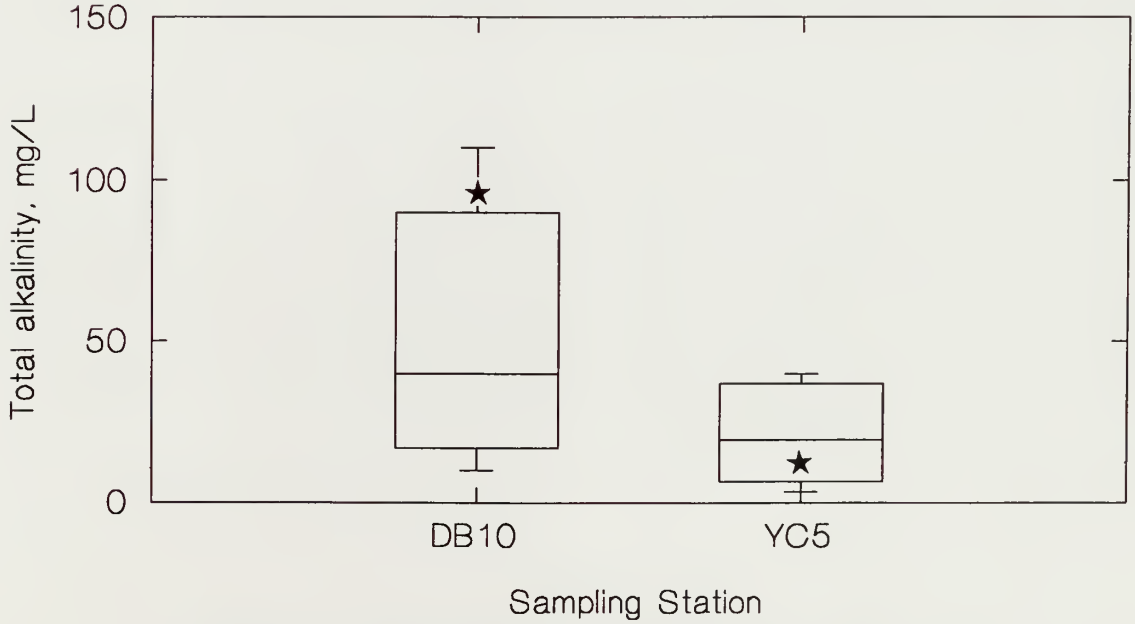

Figure 14. Total alkalinity distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

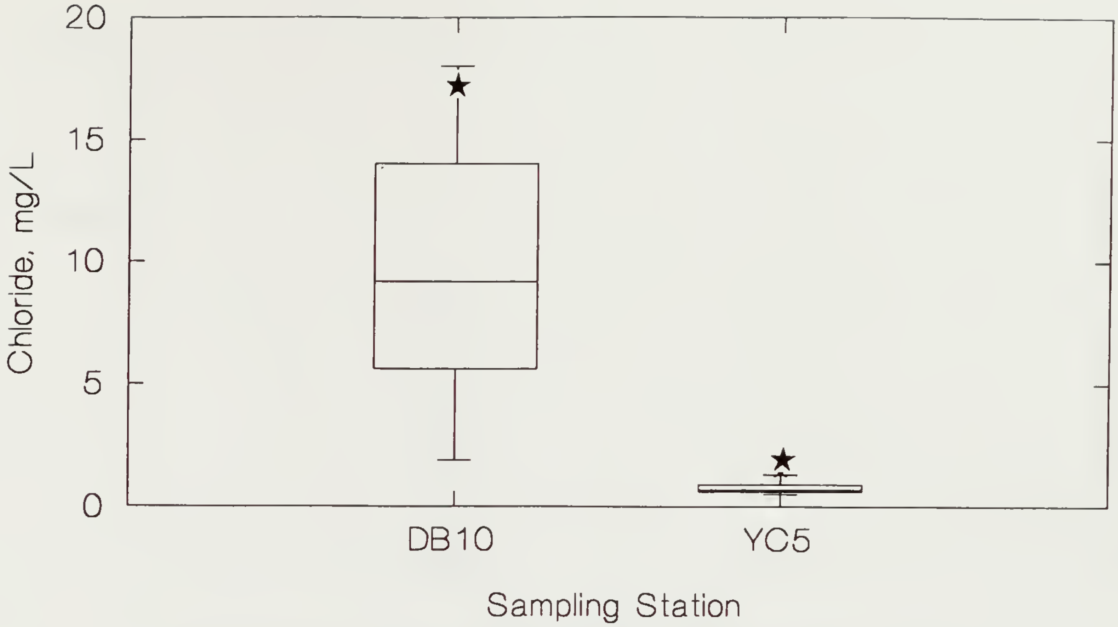

Figure 15. Chloride distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

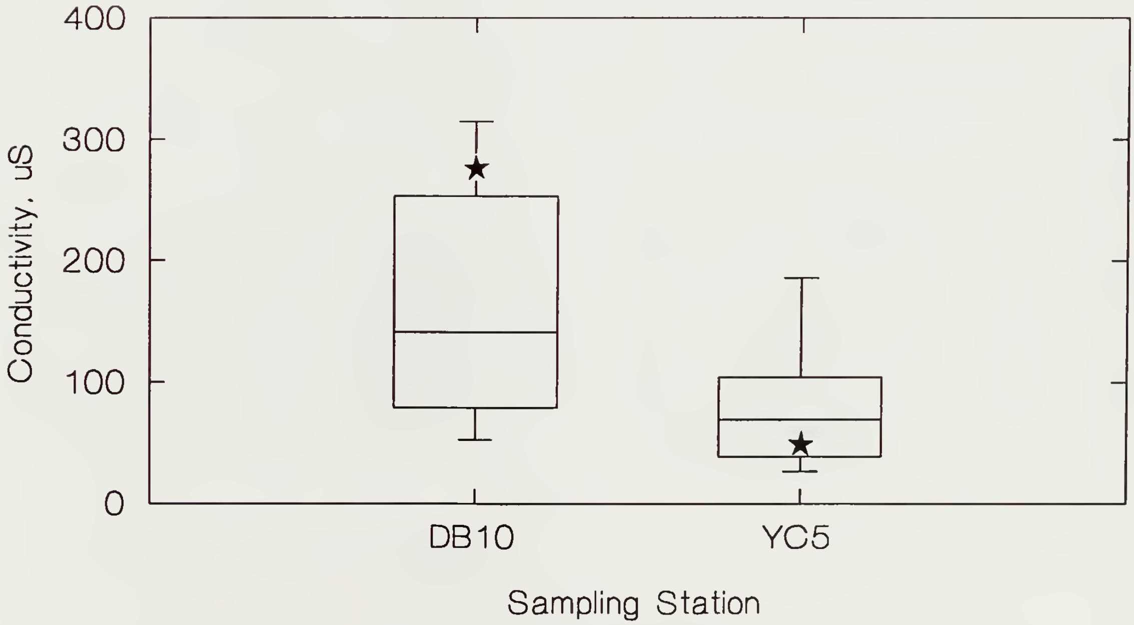

Figure 16. Conductivity distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

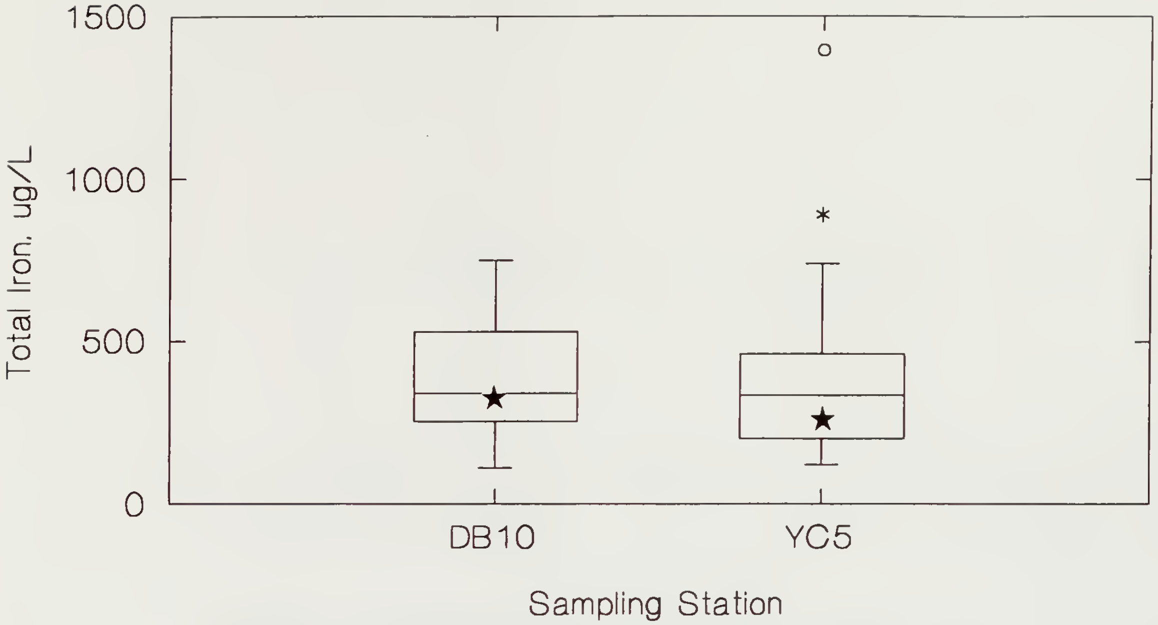

Figure 17. Total iron distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

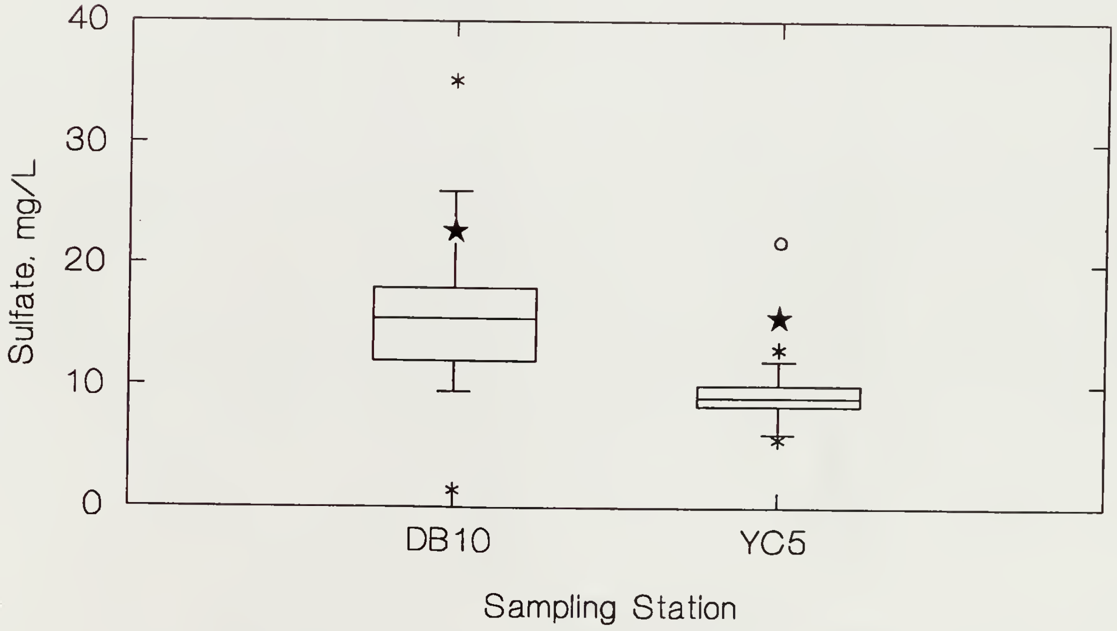

Figure 18. Total sulfate distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

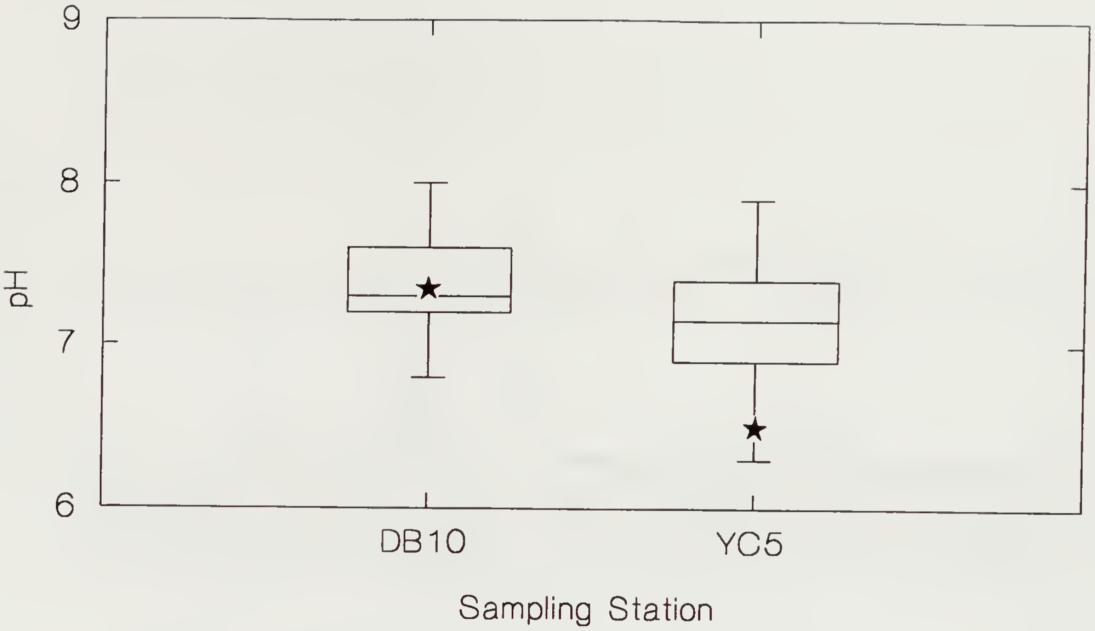

Figure 19. pH distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

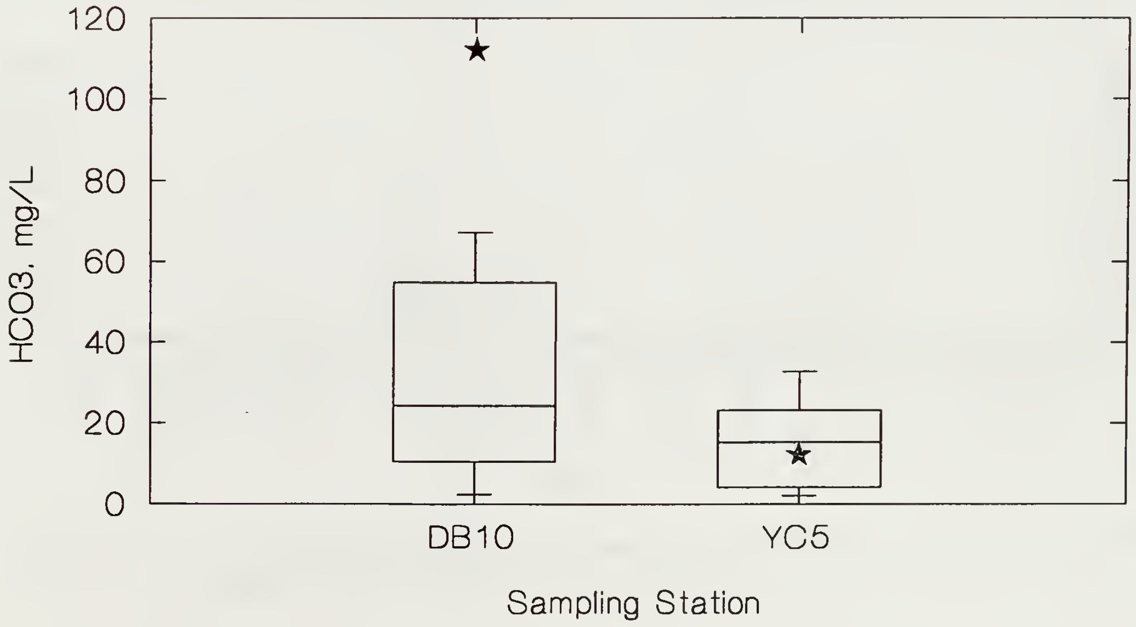

Figure 20. Bicarbonate (HCO_3) distribution at DB10 and YC5 - 1993
(★ = 1964 mean)
(See Appendix G for explanation of boxplot)

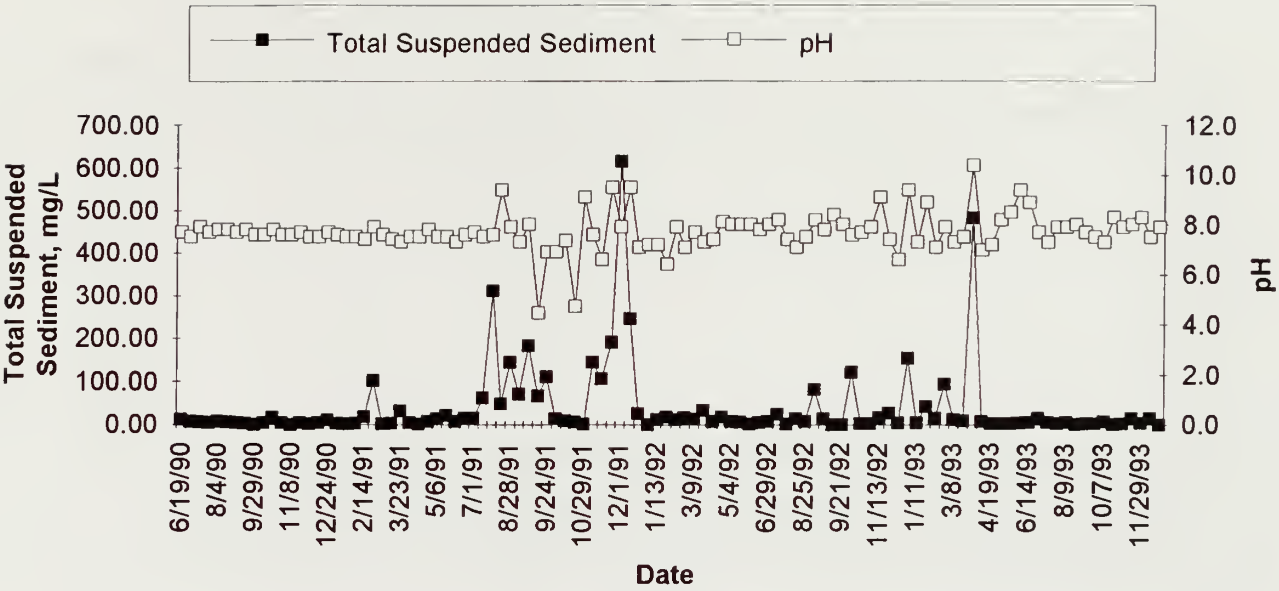

Figure 21. pH and total suspended sediment at station TC10 1990 - 1993 (Based on data in Appendices D and F)

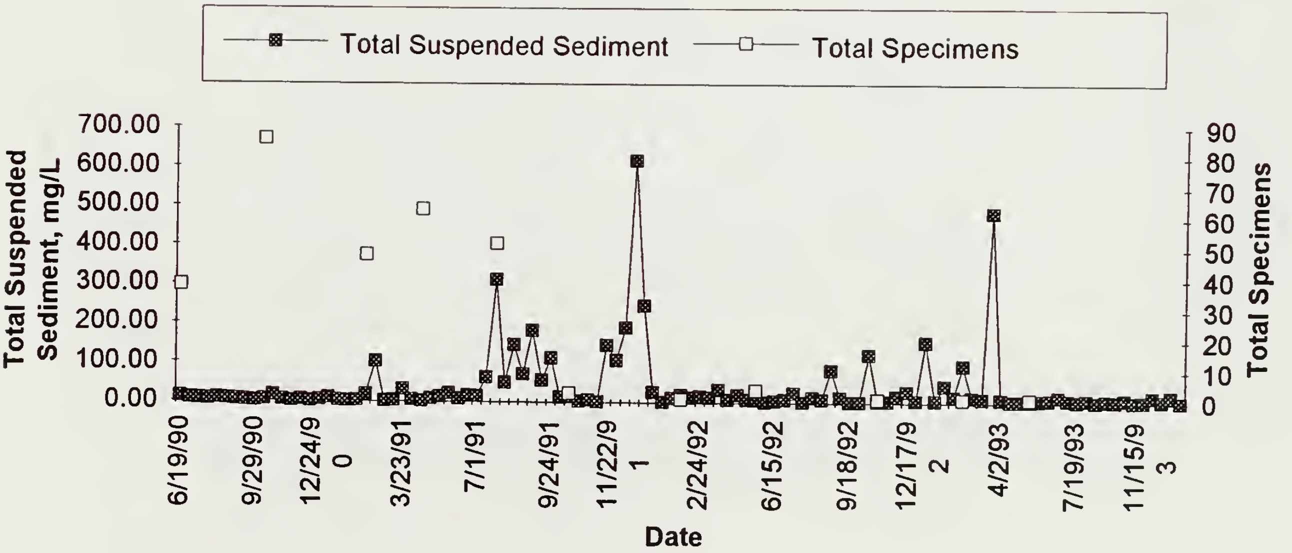

Figure 22. Total suspended sediment and total specimens at station TC10 1990 - 1993 (Based on data in Appendices D and F)

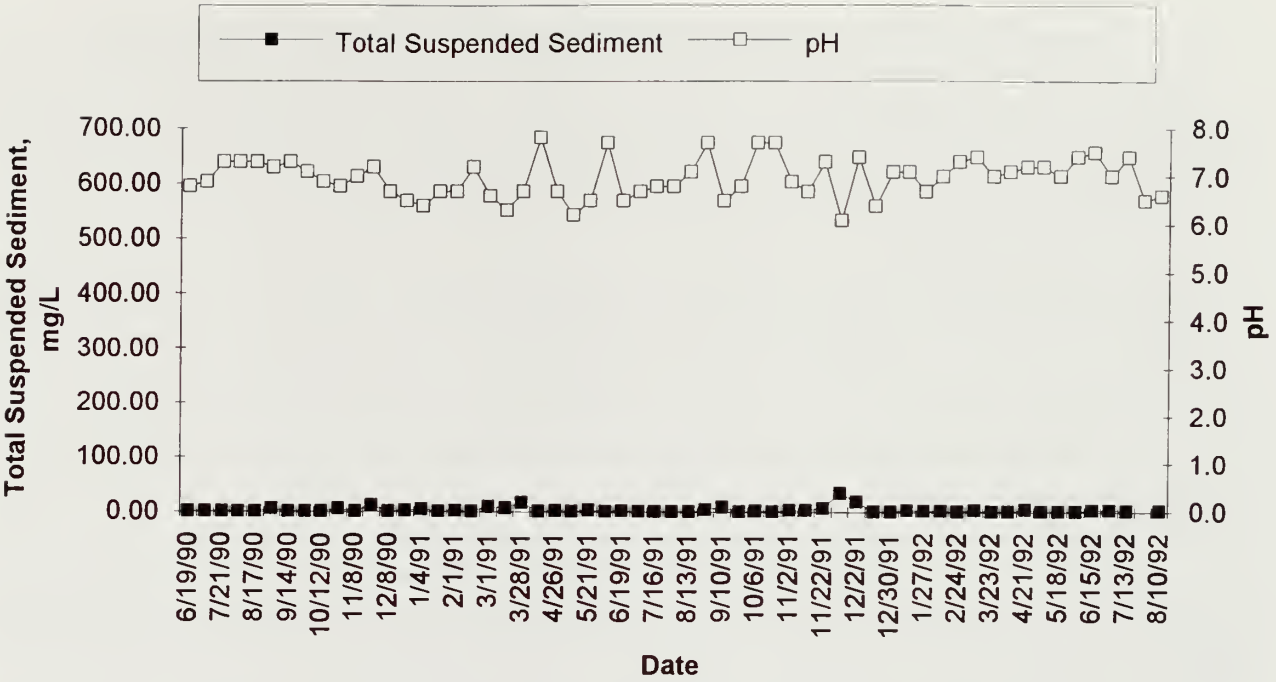

Figure 23. pH and total suspended sediment at station YC1 1990 - 1992 (Based on data in Appendices D and F)

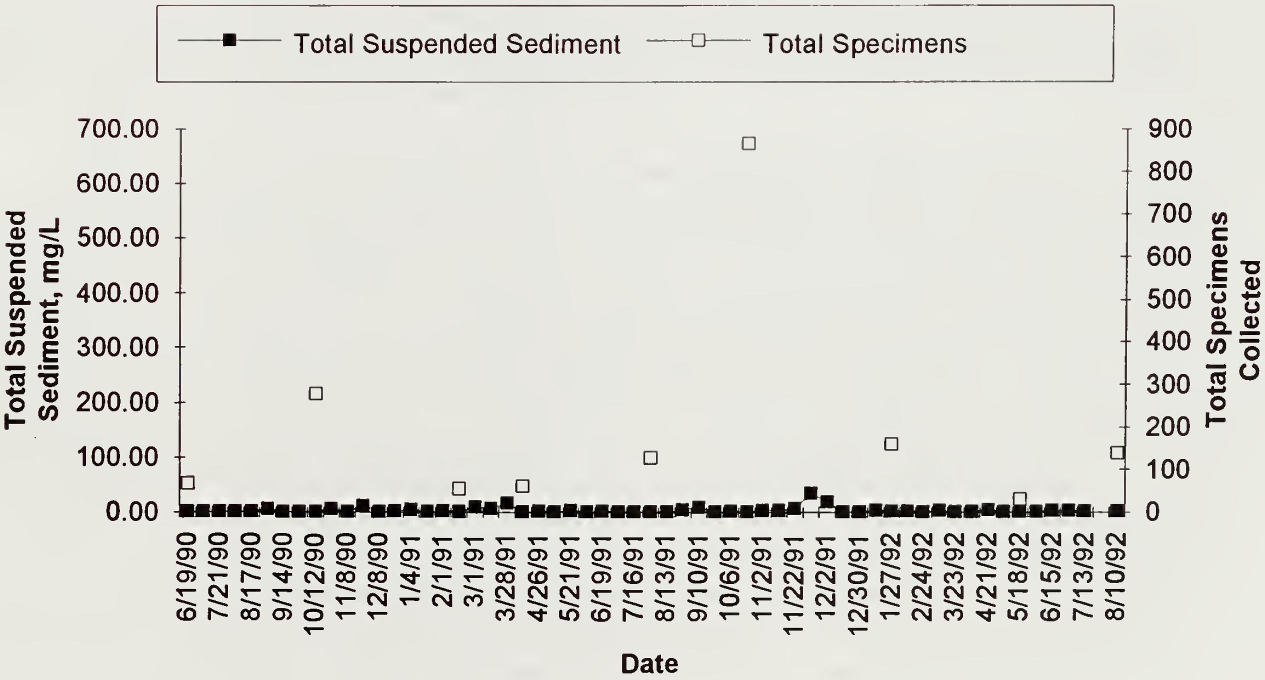

Figure 24. Total suspended sediment and total specimens at station YC1 1990 - 1992 (Based on data in Appendices D and F)

Available data suggest that the discharge from Tunnel Creek may have impacted downstream stations in Little Yellow Creek, but in the latter stream, the relationship between Tunnel Creek discharge and a decline in benthos abundance at receiving stations is not as easily demonstrated as it was at TC10. The lack of daily measurements at Little Yellow Creek stations is one factor that tends to obscure the relationship. It is also possible that the relationship is obscured by dilution of the Tunnel Creek flows. Even though in 1993 median flows at TC10 were slightly larger than at YC5, high flows at YC5 were as much as four times larger than the highest flows at TC10 (Figure 1). High sediment loads in Little Yellow Creek due to unknown causes unrelated to tunnel construction might be another obscuring factor. At YC1, The highest measured suspended sediment value was only about 34 mg/L on 12/1/91 and pH values were greater than 6.0 for the entire study period (Figure 23). As expected, benthic populations at YC1 were relatively stable with an average of about 100 specimens per sample, excluding the extremely large sample of 10/91, and they did not exhibit the abrupt decline in numbers evident at TC10. At YC5, pH values remained above 6.0, and no large fluctuations were evident (Figure 25). It appears, however, that numbers of benthic organisms in samples may have begun to decline after a suspended sediment concentration of 662 mg/L was measured at YC5 on 9/14/90. The sediment source must have been a local one, since on that date suspended sediment levels of only 1.0 and 3.0 mg/L were measured at YC1 and TC10 ,respectively. Another sediment peak of 430 mg/L was recorded at YC5 on 8/28/91 during the period when high sediment loads were occurring in Tunnel Creek. After this peak, the number of specimens in samples remained at the low levels indicated in Figure 26. It is possible that the observed decline in the number of organisms at YC5 was wholly unrelated to the Tunnel Creek discharge, but since YC5 is very close to the mouth of Tunnel Creek, although upstream, it could be speculated that some eddy effect at high flows allows Tunnel Creek to affect YC5.

Extreme sediment and pH values were not measured at YC5A, the first station downstream from the mouth of Tunnel Creek. No pH values below 6.0 were measured at YC5A, and the highest sediment load measured was 227 mg/L near the end of the period of high sediment discharge from Tunnel Creek (Figure 27). It is assumed that extremes occurred, however, and that the samples collected at two-week intervals at YC5A simply could not adequately represent the daily fluctuations in the pH and sediment load of the Tunnel Creek discharge. This assumption is supported by the fact that the pattern of benthos abundance at YC5A is similar to that at TC10, although not as pronounced (Figure 28). At YC12, apparent pH fluctuations were small, measured pH values rarely dropped below 6.5, and measured suspended sediment concentrations were generally low with the highest peak prior to 1993 being 106 mg/L on 12/2/91 (Figure 29). The abundance of benthic macroinvertebrates in YC12 samples did not appear to decline appreciably until after the 5/92 sample, when the number dropped from an average of 51 specimens per sample to an average of 11 per sample (Figure 30). The delay in the decline of macroinvertebrate abundance can possibly be attributed to the fact that YC12 is about a mile downstream from the mouth of Tunnel Creek, although the large daily pH fluctuations known to have occurred in Tunnel Creek in 1992 (Heather Rhodes, personal communication) could have been a contributing factor. At Station DB10, in Davis Branch, pH values were generally higher than 6.5, and sediment loads were generally low with the highest value measured prior to 1993

being 136 mg/L on 12/2/91 (Figure 31). As expected, no decline in benthic organisms occurred at DB10 that could be attributed to pH and suspended sediment levels in the Tunnel Creek discharge. A slight decline in abundance after the sample of 4/91 (Figure 32) appears to be of a magnitude that could be due to seasonal variation in abundance or to variation in sampling effort.

9. Conclusions

9.1 Water Quality

The results of the CUGA water monitoring program indicate that for most parameters, water quality was generally good in 1993 in the streams of interest. However, large pH fluctuations occurred in Tunnel Creek and presumably in downstream areas of Little Yellow Creek due to the basic conditions caused by tunnel construction and the addition of acid to neutralize them. At DB5, dissolved oxygen concentrations were below and dissolved iron conditions above Kentucky water quality criteria levels on several occasions. Since total manganese is significant only in public water supplies because it can cause unaesthetic staining, the fact that it frequently was found to exceed criteria levels in park streams is not considered significant. Some metals, including mercury, copper, and zinc occasionally exceeded criteria concentrations in samples, but no trends were evident, and in several cases, the samples were collected during the high flows associated with storm events.

9.2 Sediments

Streambed sediments tested in 1993 can generally be considered "nonpolluted" according to the guidelines for Great Lakes harbor sediments listed in Table 8. Some degree of pollution was found only for barium, manganese, and mercury. Moderate to heavy barium pollution was found in three samples from TD1, and samples from several other streams were nonpolluted to moderately polluted. One sample from TD1 was moderately polluted with regard to manganese, and, although no guideline was established below which mercury could be considered nonpolluting, mercury concentrations in all samples were lower than the 1 mg/kg guideline for moderate mercury pollution.

9.3 Water quality trends

After comparing sample data from the STORET database with current water quality data, it was apparent that water quality at YC5 and DB10 was not appreciably different in 1993 than it was in 1964. The data cannot be used to demonstrate the absence of adverse long-term water quality trends, because no data are available for the intervening years.

Declines in the abundance of benthic macroinvertebrates at some sampling stations in Tunnel Creek and Little Yellow Creek suggest that acidic conditions and sedimentation resulting from tunnel construction activities have degraded the biological carrying capacities of the affected areas of the streams.

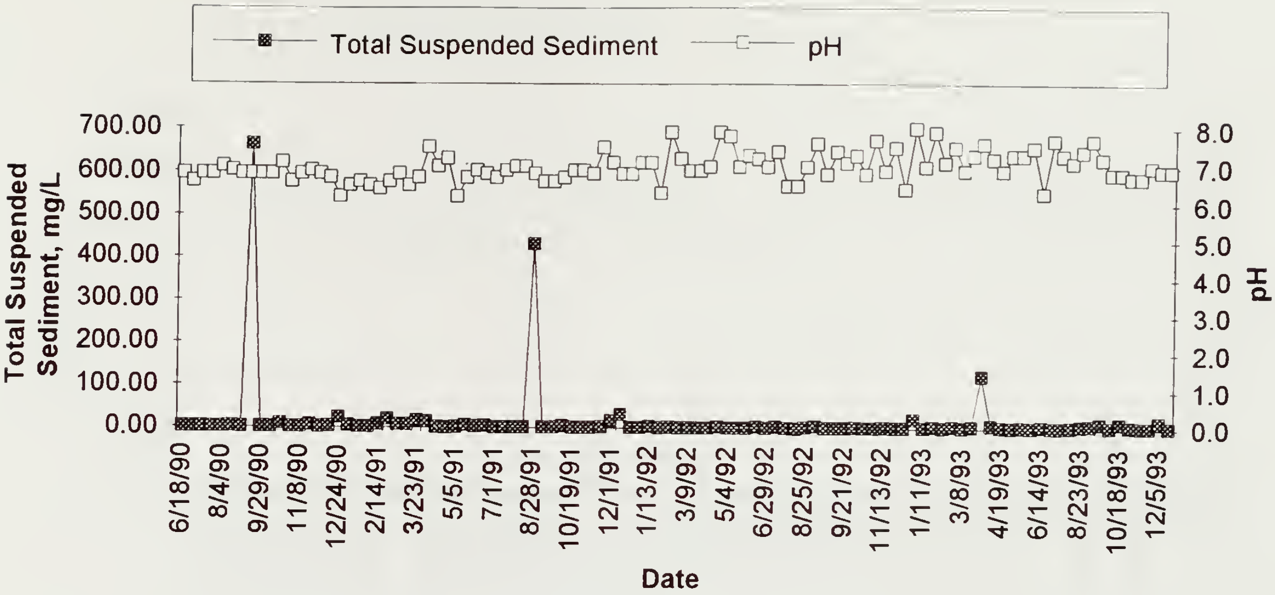

Figure 25. pH and total suspended sediment at station YC5 1990 - 1993 (Based on data in Appendices D and F)

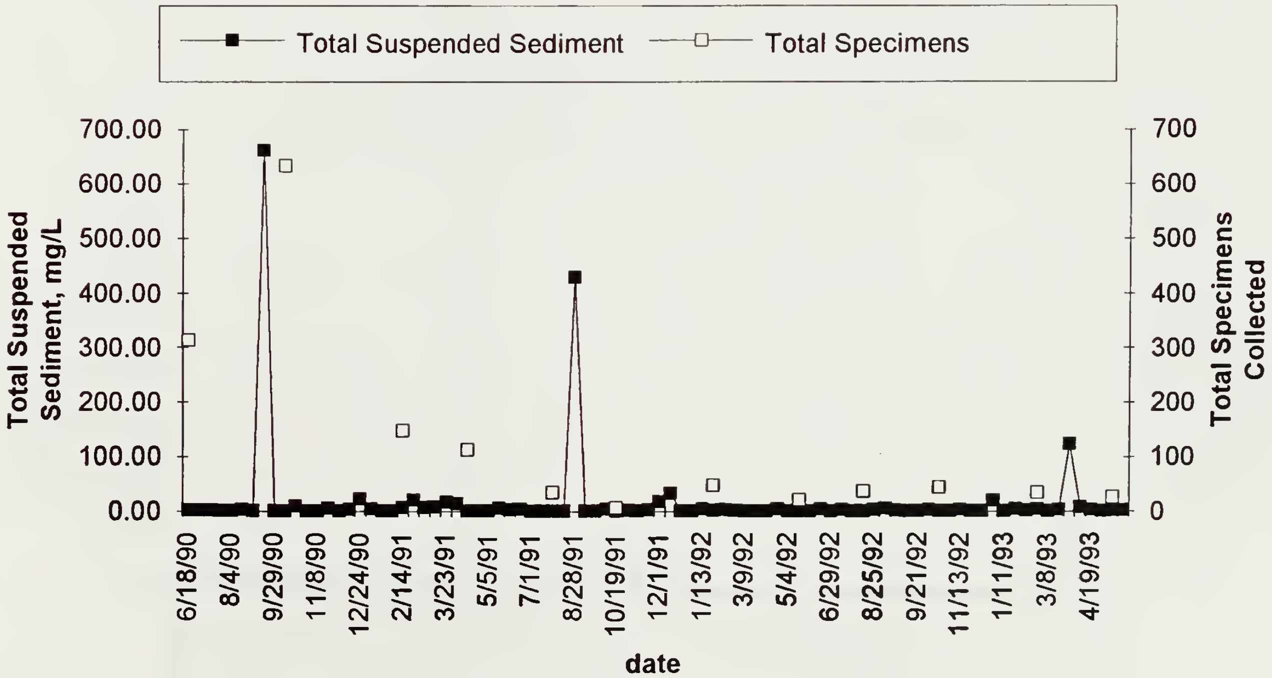

Figure 26. Total suspended sediment and total specimens at station YC5 1990 - 1993 (Based on data in Appendices D and F)

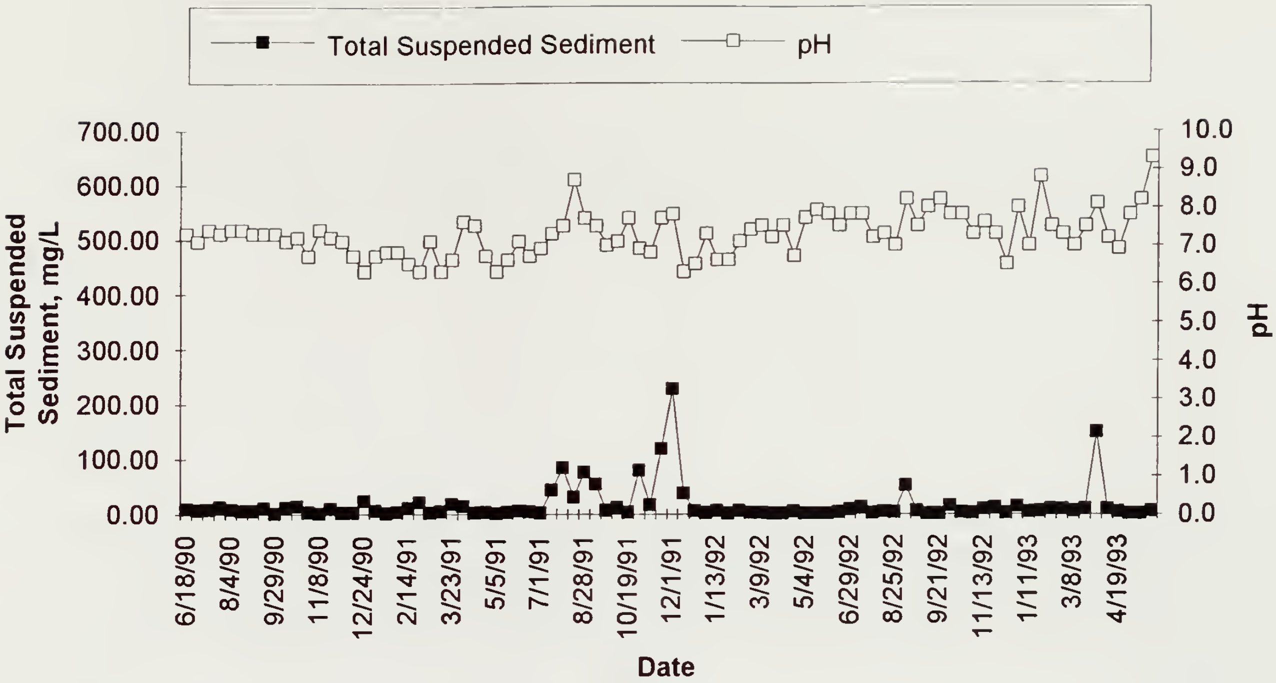

Figure 27. pH and total suspended sediment at station YC5A 1990 - 1993 (Based on data in Appendices D and F)

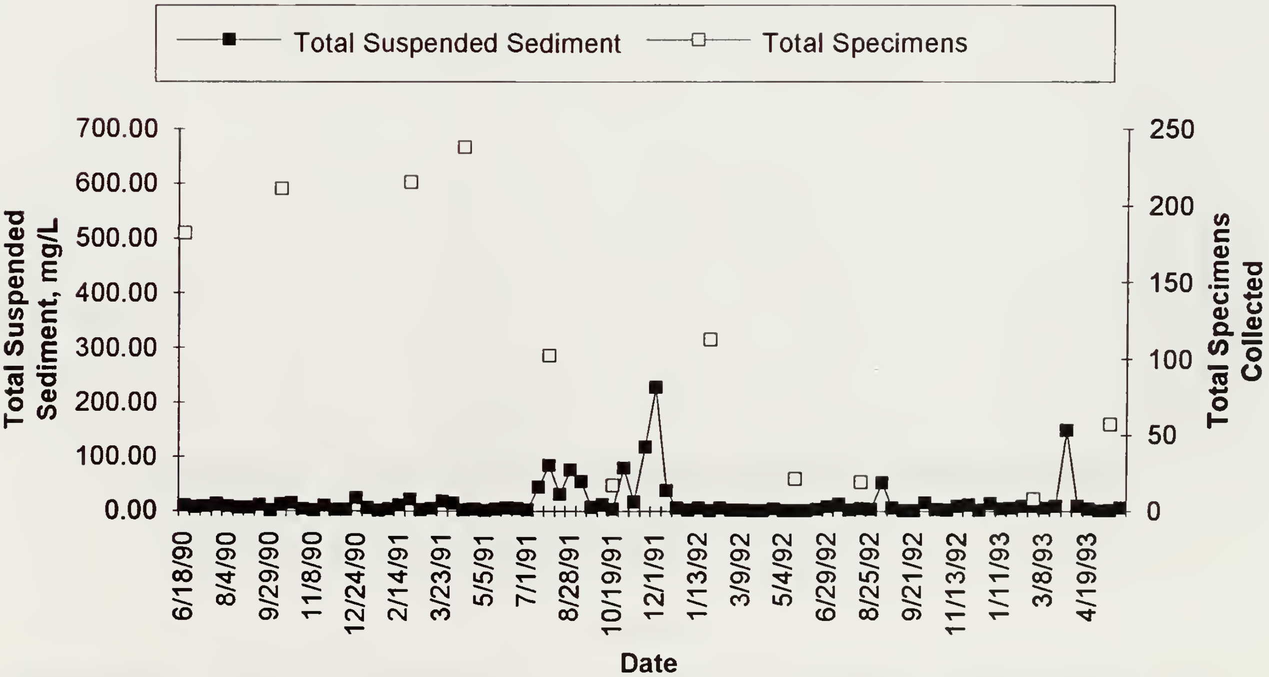

Figure 28. Total suspended sediment and total specimens at station YC5A 1990 - 1993 (Based on data in Appendices D and F)

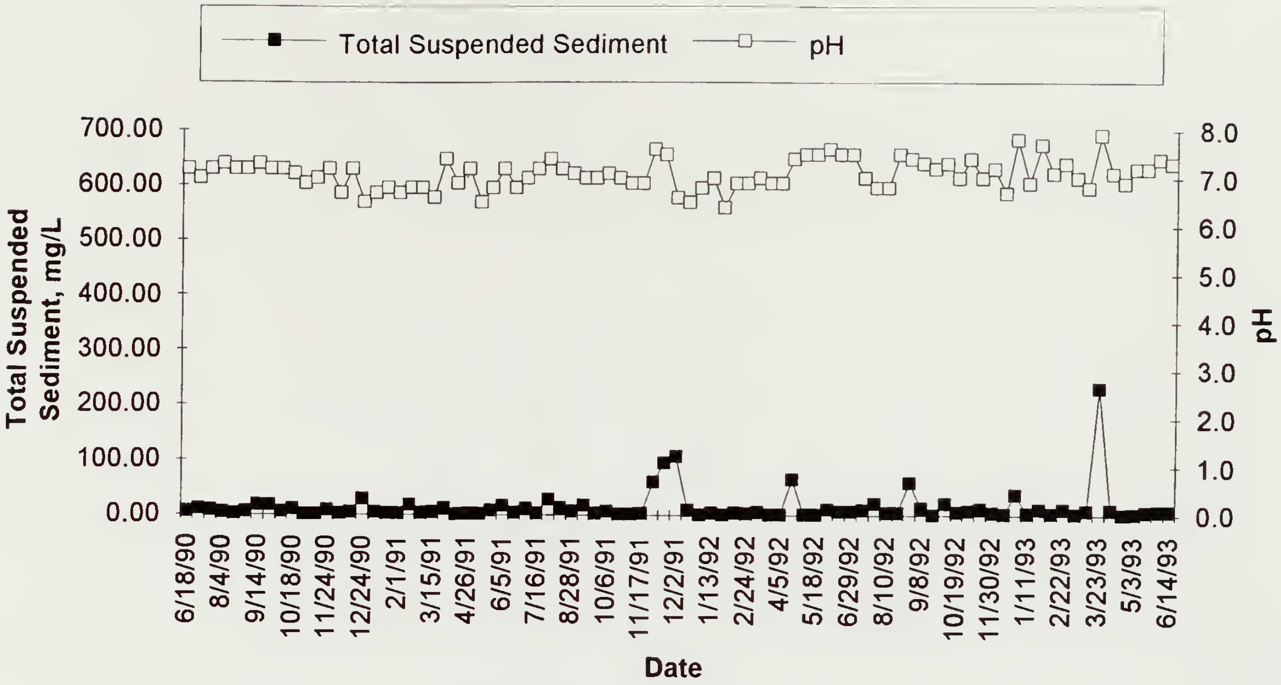

Figure 29. pH and total suspended sediment at YC12 1990 - 1993 (Based on data in Appendices D and F)

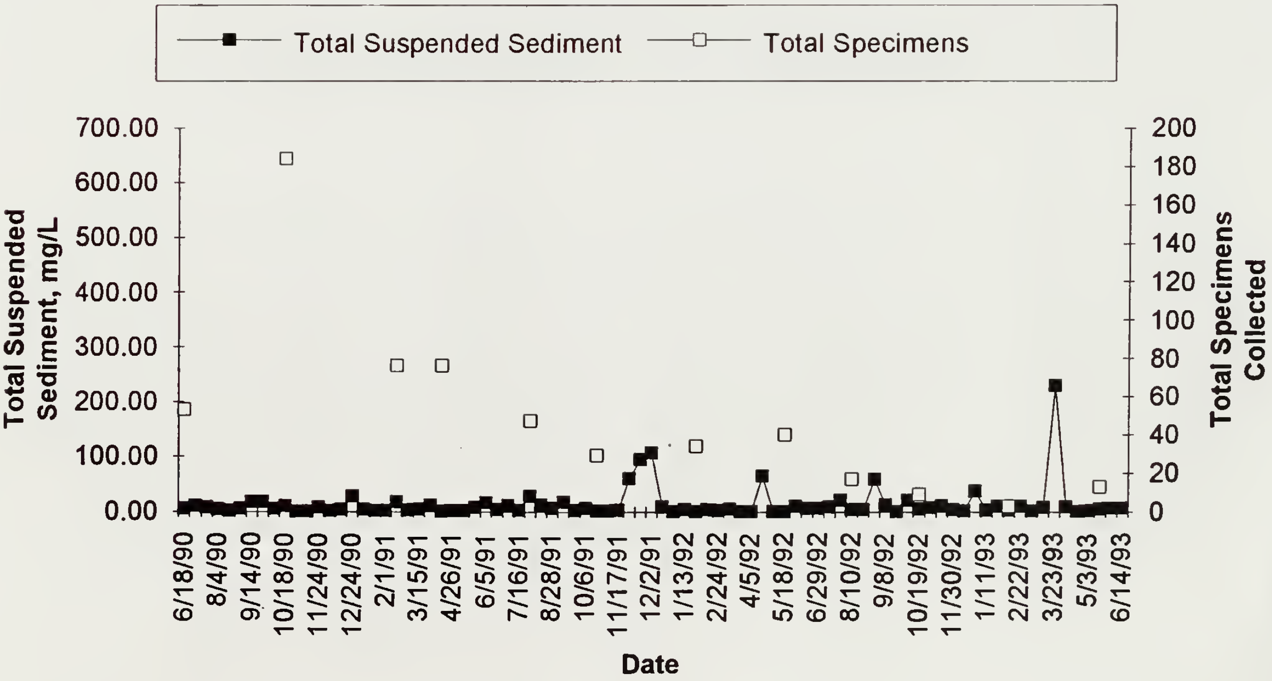

Figure 30. Total suspended sediment and total specimens at station YC12 1990 - 1993 (Based on data in Appendices D and F)

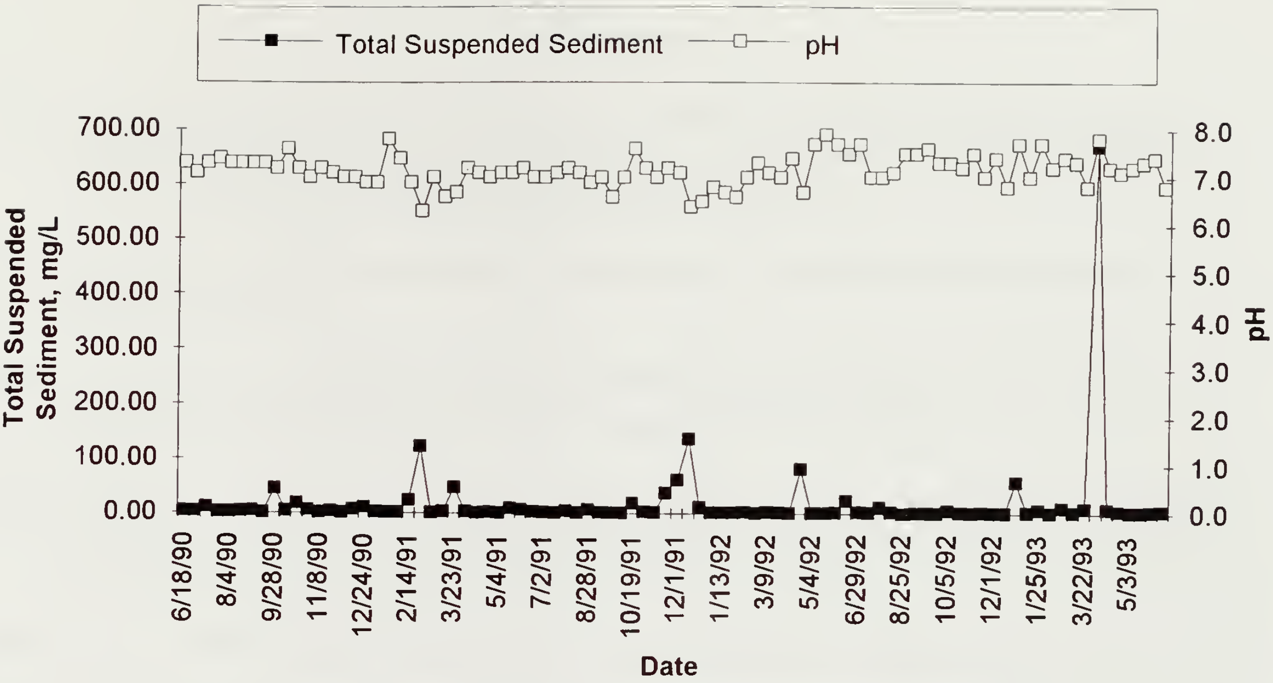

Figure 31. pH and total suspended sediment at station DB10 1990 - 1993 (Based on data in Appendices D and F)

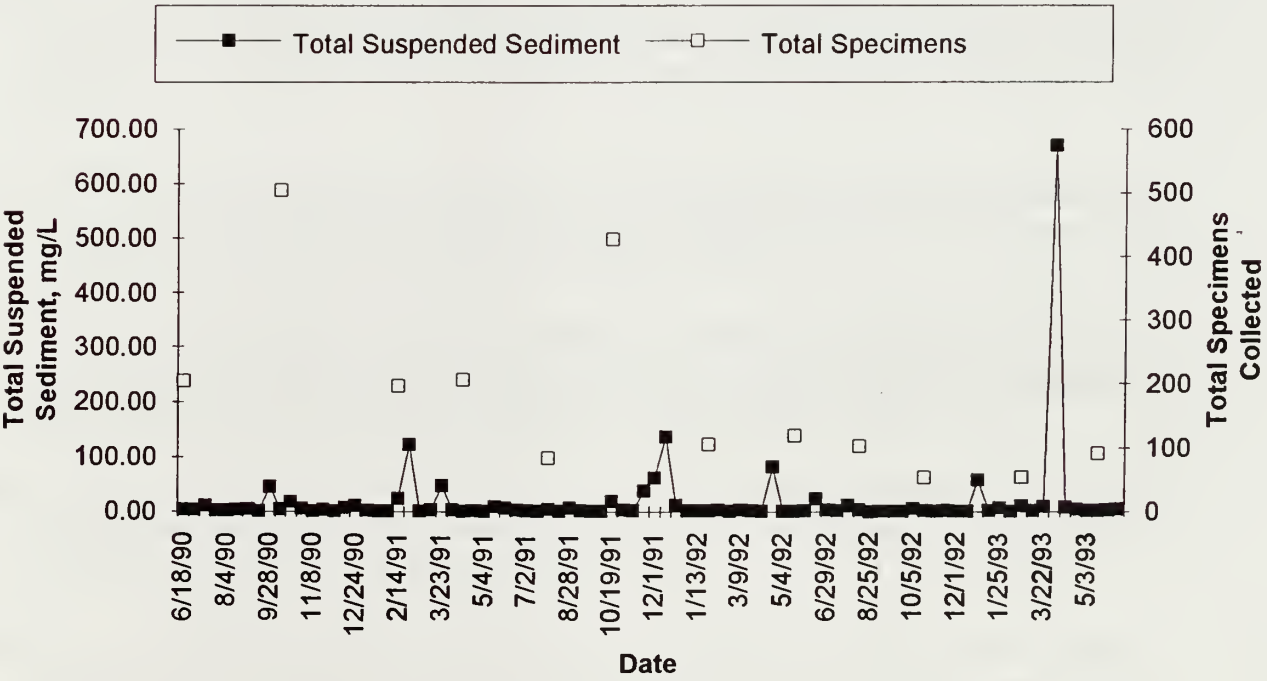

Figure 32. Total suspended sediment and total specimens at station DB10 1990 - 1993 (Based on data in Appendices D and F)

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Appendices

Appendix A: Stream, watershed, and sampling station information

Appendix B: 1993 water quality data

Appendix C: 1993 sediment chemistry data

Appendix D: Summary of benthic macroinvertebrate samples June 1990 to May 1993

Appendix E: STORET database data

Appendix F: Data for Figures 21 through 32

Appendix G: Tukey boxplots

Appendix H: Daily sampling data from Station TC10 - 1993

Appendix A

Stream, Watershed, and Sampling Station Information

The descriptions in this appendix are based on information provided by Mr. Jimmy W. Johnson of the National Park Service, Mr. Shane Sturgill, a University of Tennessee employee who performs the sampling a personal tour of the sampling stations on March 18, 1994, and a review of U.S.G.S. 7.5-minute topographic quadrangle maps.

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A.1 Introduction

This appendix contains information concerning stations at which water and\or sediment samples were collected in 1993. At the end of the Appendix, watershed maps (Figures A-2 through A-4) are provided with station locations marked , and a summary map (Figure A-1) indicates the location of each watershed within the park.

A.2.1 Dark Ridge Creek (DR9)

Stream Description:	Dark Ridge Creek is located in Kentucky in the northwest section of the park. The stream, which is too small to be depicted on the topographic map which was reviewed, reportedly originates in a hollow on the east slope of Dark Ridge and flows east for approximately 0.15 miles before entering Sugar Run near the park boundary a short distance downstream from station SR10. Dark Ridge Creek reportedly flows continuously and is about 3 to 4 feet wide near its confluence with Sugar Run.
Watershed Description:	The Dark Ridge Creek watershed is small, with an area of about 0.1 square miles. It is located entirely in Kentucky in the northwest section of the park between the Davis Branch and Sugar Run watersheds (Figure A-1). Past impacts include timber removal and the construction of a segment of Hwy. 988. The only current potential source of adverse impact to the water quality of Dark Ridge Creek is runoff from Hwy. 988.
Sampling Stations:	DR9: Located on Dark Ridge Creek near its confluence with Sugar Run (near the point at which Sugar Run exits the park.) It replaced SR10 as a monitoring point for planned Hwy. 988 straightening which was to have been carried out by using fill materials excavated from the tunnel. The proposed roadwork was blocked by the discovery of a federally listed threatened species, the blackside dace (Phoxinus cumberlandensis), in the adjacent Davis Branch, and roadwork was limited to resurfacing. Since the anticipated construction did not occur, DR9 is now sampled only on an annual or, at most, quarterly basis. In 1993, it was sampled once on 8/23.
Maps Reviewed:	U. S. G. S. 7.5-minute topographic quadrangles 1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991) 2. Middlesboro North, Ky. 1974 3. Middlesboro North, Ky. 1959

A.2.2 Davis Branch (DB5, 6, 7, 8, 10)

Stream Description:	Davis Branch is located in Kentucky and is entirely contained in the northwest section of the park. It is approximately 2.7 miles in length, and it flows south to enter Little Yellow Creek between YC5A and YC6 (Figure A-2). It contains a federally listed threatened minnow, the blackside dace (Phoxinus cumberlandensis). State Route 988 (Sugar Run Road) lies adjacent to much of the upper section of the stream, and U. S. 25E parallels the lower section.
Watershed Description:	The Davis Branch watershed has an area of about 1.2 square miles, all of which is located in the park (Figure A-1). Historically, the watershed has probably been affected by timbering. At present, potential sources of adverse impact appear to be limited to runoff from State Route 988 in the north , from U. S. 25E in the south, and from a service road and rifle range near the stream in the vicinity of Hwy. 988.
Sampling Stations	DB5: Located in the upper reaches of Davis Branch above the influence of State Route 988. It is used as a control station. There appeared to be a considerable coating of sediment on the rocks of the stream bottom when I visited the station on March 18, 1994. Perhaps the sediment was due to reported upstream beaver activity. In 1993, water samples were collected at DB5 at approximate two-week intervals and after storm events until 9/7, and one additional sample was collected on 12/5. Sediment samples were collected at quarterly intervals through 10/19, and benthic macroinvertebrate samples were collected in at least the first two quarters. DB6, DB7, DB8: Located along the middle reaches of Davis Branch. These stations were established primarily to study the blackside dace population. Reportedly, initial dissolved oxygen measurements were made when the stations were established. No water or sediment samples were collected in 1993. DB10: Located approximately 100 yards above Davis Branch's confluence with Little Yellow Creek. It is used to monitor the effects of all upstream impacts to Davis Branch. This station is located between abutments of a bridge which no longer exists; therefore, it has been affected historically by bridge construction and possible highway runoff. In 1993, water samples were collected at approximate two-week intervals and after storm events. Sediment samples were collected at quarterly intervals through 10/19, and benthic macroinvertebrate samples were collected in at least the first two quarters.
Maps Reviewed:	U. S. G. S. 7.5-minute topographic quadrangles 1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991) 2. Middlesboro North, Ky. 1974 3. Middlesboro North, Ky. 1959

A.2.3 Gap Creek (GC3, 4, 7)

Stream Description:

Gap Creek originates on Cumberland Mountain in Cudjo Cave a short distance north of the Virginia-Tennessee state line. It flows south down the mountain, passes beneath U. S. 25E, and through the town of Cumberland Gap, Tennessee (Figure A-2). Only about a mile of the stream's upper reaches lie within the park when the portion within the town's boundaries is excluded. Gap Creek is a narrow, high-gradient stream with an irregular, rocky bottom until approximately the point at which it crosses the state line and enters the town. The gradient then begins to diminish and the bottom becomes more regular. Near the south side of town, a tributary which receives runoff from U. S. 58 enters Gap Creek. In addition, outflow from the tunnel cavern emerges in an area used by the town as a dump, passes Station TD1, and enters Gap Creek near the mouth of the tributary .

Watershed Description:

Only the upper portion of the Gap Creek watershed is included in the monitoring program because it is the only portion which can be affected by tunnel construction and highway construction activities. It is approximately 0.9 square miles in area and encompasses the town of Cumberland Gap as well as portions of U. S. 25E and U. S. 58 (Figure A-2). In the watershed, major potential sources of adverse impact to the water quality of Gap Creek include the sewage treatment plant discharge and surface runoff from the town, runoff from the town dump located over the tunnel discharge outflow, and proposed future construction on U. S. 58.

Sampling Stations

GC3: Located within the town of Cumberland Gap (Figure A-2). It serves as a control for the effects of tunnel discharge and highway construction runoff on Gap Creek. Water quality at GC3 could potentially be influenced by surface runoff from U. S. 25E and from nearby parts of the town. To avoid disturbing a population of stocked rainbow trout, benthic macroinvertebrate samples (which are labeled as originating from GC3) are collected upstream near the iron furnace in the high-gradient section. In 1993, water samples were collected at GC3 at approximate two-week intervals and after storm events, and three sediment samples were collected through 7/6. Benthic macroinvertebrate samples were collected in at least the first two quarters.

GC4: Located on the tributary which receives runoff from U. S. 58 (Refer to Stream Description) near its confluence with Gap Creek (about 100 feet below GC3) (Figure A-2). It will be used to monitor the effects on water quality of construction of U. S. 58. It is not presently monitored, since no construction is in progress. It potentially could reflect the effects of surface runoff from nearby parts of the town as well as from U. S. 58. In 1993, water samples were collected at GC4 at approximate two-week intervals and after storm events through 9/21.

GC7: located about 0.65 miles downstream from GC3 and about 0.28 miles upstream from the park boundary (Figure A-2). Used to monitor the persistence of adverse water quality effects from the influences mentioned. In 1993, water samples were collected at GC7 at approximate two-week intervals and after storm events, and sediment samples were collected at quarterly intervals through 10/19. Benthic macroinvertebrates were sampled in at least the first two quarters..

Maps Reviewed: U. S. G. S. 7.5-minute topographic quadrangles
1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991)

A.2.4 Lewis Hollow (Unnamed stream)

Stream Description: The stream segment of interest in this study is approximately 1.0 miles long. It originates in, and is entirely contained within, Lewis Hollow on the Virginia side of Cumberland Mountain (Figure A-2). After flowing south out of Lewis Hollow, the stream crosses beneath U. S. 58 and flows east along the southern border of the park to join Station Creek outside the park boundary. The stream segment serves as a control to monitor the effects of planned future construction on U. S. 58.

Watershed Description: Lewis Hollow constitutes the entire watershed for the stream segment of interest, an area of about 0.3 square miles. The watershed is located about one-third of the way along the park's southern boundary from the west end (Figure A-1). Past impacts to the watershed reportedly include selective timber removal in the 1950's prior to the establishment of the park. A map review does not indicate any potential source of adverse impact to the water quality of the stream other than a hiking trail along the ridge at the head of the hollow.

Sampling Stations: LH5: Located at the mouth of Lewis Hollow about 50 feet upstream from U. S. 58) (Figure A-2). In 1993, only three water samples were collected at LH5, two of which were associated with storm events , and sediment samples were collected in the first three quarters. Benthic macroinvertebrates were collected in at least the first two quarters.

Maps Reviewed: U. S. G. S. 7.5-minute topographic quadrangles

1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991)
2. Wheeler, Tenn. - Va. 1956 (Photorevised 1978)
3. Wheeler, Tenn. - Va. 1956

A.2.5 Little Yellow Creek

Stream Description: Little Yellow Creek flows northeast from Tennessee into Kentucky and enters the park near the middle of its west side (Figure A-3). It abruptly turns west forming the boundary between the park and the town of Middlesboro before exiting the park to the north. The dam forming Fern Lake, a 170-acre impoundment on Little Yellow Creek, is located about 0.6 stream miles outside the park boundary. Tunnel Creek and Davis Branch are important tributaries to the section of Little Yellow Creek which lies inside the park.

Watershed Description: The Little Yellow Creek watershed has an area of about 5.8 square miles. Only about 20 percent of the watershed, generally, that which lies north of the Fern Lake Dam, is located inside the park (Figure A-3). Reportedly, the in-park watershed historically supported some mining and logging activity. This part of the watershed includes part of the town of Middlesboro, Kentucky, a segment of U. S. 25E (part of which was under construction in 1991), facilities of the Union College Environmental Education Center, various secondary roads and several other buildings. Fern Lake serves as a water supply reservoir for the town of Middlesboro. It is likely that the lake, which is fed by runoff from the watershed outside the park, acts as a settling basin for sediment and buffers acid mine drainage from the strip mines and shallow deep mines reportedly present in that section of the watershed. Reportedly, its water is of good quality and requires very little treatment. A review of the 1959 Fork Ridge, Tenn.-Ky. topographic map discovered little human habitation, no stripmines, and no industry in the watershed south of the Fern Lake dam (outside the park). It is likely that the human population and the number of stripmines in that area have increased over the past twenty-five years.

Sampling Stations: YC1: Most upstream station in the park on Little Yellow Creek. It is located at the park boundary about 0.6 stream miles below the Fern Lake dam (Figure A-3), and it is unaffected by any construction activities in the park. Serves as a control station to monitor the effects of tunnel or highway construction activities on Little Yellow Creek. In 1993, no water or sediment samples were collected at YC1, but benthic macroinvertebrates were sampled at least in the first two quarters.

YC5: Located about 0.75 miles downstream from YC1 and a short distance upstream from the confluence of Tunnel Creek with Little Yellow Creek (Figure A-3). Since it is unaffected by the Tunnel Creek discharge and is unlikely to be affected by highway construction, it also serves as a control station to monitor the effects of tunnel or highway construction activities on Little Yellow Creek. In 1993, water samples were collected at approximate two-week intervals and after

storm events, and sediment samples were collected quarterly. Benthic macroinvertebrates were sampled in at least the first two quarters.

YC5A: Located approximately 70 yards downstream from YC5 and a short distance downstream from the confluence of Tunnel Creek with Little Yellow Creek. It is used to monitor the maximum impact of tunnel construction on Little Yellow Creek. When YC5A was visited on July 14, 1994, sediment from Little Yellow Creek was visible over about half of the stream width in the area of the station. In 1993, water samples were collected at approximate two-week intervals and after storm events, and sediment samples were collected quarterly. Benthic macroinvertebrates were sampled in at least the first two quarters.

YC6: located about 0.4 miles downstream from YC5A (Figure A-3). It is used to monitor the effects of tunnel construction on Little Yellow Creek . It is also located in an area which could be affected by runoff from construction of U. S. 25E or by surface runoff or subsurface drainage from Middlesboro. Water sampling was discontinued at YC6 after 8/92 when beavers reportedly flooded the trailer park adjacent to the creek. Benthic macroinvertebrate sampling was discontinued after 10/92. On March 18, 1994, I observed trash along the creek in the area of the station and a drain tile (apparently from a soil stockpile near U. S. 25E) which was positioned to discharge into the creek.

YC12: Located about 0.6 miles downstream from YC6 (Figure A-3). It is located at the point at which Little Yellow Creek exits the park. It is likely that the effects of tunnel construction are somewhat less at this station than at more upstream stations, but it is probably affected by runoff from the construction of U. S. 25E and by surface runoff and subsurface drainage from Middlesboro. Water samples were collected regularly at YC12 until 9/93. It is now sampled only after storm events. Benthic macroinvertebrate samples were collected in at least the first two quarters of 1993. Although fecal coliform counts are reported to be high, beaver, and a variety of fish and benthic macroinvertebrates including mussels are reported to be present.

Maps Reviewed: U. S. G. S. 7.5-minute topographic quadrangles

1. Middlesboro South, Ky.-Tenn.-Va. 1974 (Photorevised 1991)
2. Fork Ridge, Tenn.-Ky. 1959
3. Mingo Mtns., Tenn. - Ky. 1950

A.2.6 Martins Fork (of the Cumberland River) (MF2, 5)

Stream Description:	The upper reaches of Martins Fork which are being monitored for this study flow from west to east along the top of Cumberland Mountain entirely within the Kentucky section of the park near the park's eastern end (Figure A-4). This section of Martins Fork is about 3.6 miles long, and is described by park personnel as "a small, acidic, backcountry stream." The entire stream segment serves as a control to monitor the effects of tunnel and highway construction and other activities on the waters and sediments of other streams in more heavily frequented areas of the park. In 1993, water samples were collected at both stations three times through 10/15, and benthic macroinvertebrates were sampled on 2/93.
Watershed Description:	The section of the Martins Fork watershed which is included in this study lies almost entirely within the park and has an area of about 2.1 square miles. It is situated in a remote, region of the park, and backpackers and a small picnic area are the only apparent potential sources of adverse impacts to water quality. In the past, the watershed may have been impacted by timbering.
Sampling Stations:	MF2: Located in the extreme upper reaches of Martins Fork (Figure A-4). It is adjacent to a small picnic area. MF5: Located about 3.5 miles downstream from MF2 (Figure A-4) . Marks the downstream limit of the Martins Fork study area.
Maps Reviewed:	U. S. G. S. 7.5-minute topographic quadrangles 1. Varilla, Ky. - Va. 1974 (Photorevised 1991) 2. Varilla, Ky. - Va. 1954 3. Ewing, Ky. - Va. 1946 (Photorevised 1969)

A.2.7 Shillalah Creek (SH10)

Stream Description: The portion of Shillalah Creek being monitored for this study flows from east to west along the top of Cumberland Mountain entirely within the Kentucky section of the park (Figure A-7). It is located west of the Martins Fork watershed, near the center of the park's east-west extent (Figure A-1). This section of Shillalah Creek is about 3.4 miles long, and is described by park personnel as " a small, acidic, backcountry stream." The entire stream segment serves as a control to monitor the effects of tunnel and highway construction and other activities on the waters and sediments of streams in more heavily frequented areas of the park.

Watershed Description: The section of the Shillalah Creek watershed that is included in this study lies almost entirely within the park and has an area of about 1.4 square miles. It is situated in a remote region of the park; therefore, backpackers and a small restored community with riding stables known as the Hensley Settlement are the only apparent sources of potential adverse impacts to water quality. In the past, the watershed may have been impacted by timbering, and activities in the original Hensley Settlement.

Sampling Stations: SH10: Located at the point where Shillalah Creek exits the park (Figure A-4). It is the only sampling station on Shillalah Creek. In 1993, water samples were collected at SH10 three times through 10/15 and benthic macroinvertebrates were sampled once on 2/93.

Maps U. S. G. S. 7.5-minute topographic quadrangles

1. Varilla, Ky. - Va. 1974 (Photorevised 1991)
2. Varilla, Ky. - Va. 1954

A.2.8 Station Creek (ST5, 10)

Stream Description: Station Creek originates on Cumberland Mountain in the Virginia section of the park. After about 1.25 miles, it exits the park, flows west along the park's southern boundary for approximately a mile, turns south after reentering the park, and after about another mile, again exits the park's southern boundary at U. S. 58 about two miles east of the U. S. 25E-U. S. 58 intersection on the Virginia side of the Virginia-Tennessee state line (Figure A-2).

Watershed Description: The portion of the Station Creek watershed which supplies the stream section described above has an area of about 1.7 square miles. It is located entirely in Virginia, and mostly within the park. Historically, it is likely that the watershed was affected by timbering. A review of topographic maps suggests that the watershed is presently entirely undeveloped with the exception of a campground near where the creek finally leaves the park.

Sampling Stations: ST5: Located about 0.45 miles north of the point at which Station Creek intersects U. S. 58 as it exits the park (Figure A-2). ST5 will serve as a control to monitor the effects on Station Creek of future highway construction on U. S. 58, and of timber removal which recently occurred on nearby private property.

ST10: Located at the point at which Station Creek intersects U. S. 58 (at the park boundary) (Figure A-2). It is used to monitor the impacts on water quality of a 150-site campground with a septic system and future impacts of highway construction on U. S. 58. In 1993, quarterly sediment samples were collected at ST10.

In 1993, at both stations, water samples were collected on 1/11 and 12/5, and benthic macroinvertebrates were sampled in at least the first two quarters.

Maps Reviewed: U. S. G. S. 7.5-minute topographic quadrangles

1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991)
2. Varilla, Ky. - Va. 1974 (Photorevised 1991)
3. Wheeler, Tenn. - Va. 1956 (Photorevised 1978)

A.2.9 Sugar Run (SR10)

Stream Description:	Sugar Run originates in the park, on the Kentucky side of Cumberland Mountain. It flows north for approximately 2.0 miles to exit the park near its northwest corner (Figure A-9). It is joined by an unnamed tributary about 0.7 miles upstream from the park boundary.
Watershed Description:	The section of the Sugar Run watershed that is included in this study lies entirely within the Kentucky section of the park and has an area of about 1.2 square miles. It is located adjacent to the Davis Branch watershed in the northwest section of the park (Figure A-1). The Sugar Run watershed has probably been affected historically by timbering. Current potential sources of adverse impacts to Sugar Run water quality are a small section of Skyland Road in the southwest corner of the watershed ,and, in the northern tip of the watershed, a picnic area, septic system, and a short segment of Hwy. 988.
Sampling Stations:	SR10: Located adjacent to the picnic area and Hwy. 988 near the point where Sugar Run exits the park (Figure A-2). It was originally intended for use in monitoring planned construction on Hwy. 988; however, it was later decided that station DR9 could be better used for that purpose, and that SR10 would be used as a control. Regular water and benthic macroinvertebrate sampling at SR10 was discontinued after 1/92. In 1993, one sediment sample was collected at SR10 on 7/6.
Maps Reviewed	U. S. G. S. 7.5-minute topographic quadrangles 1. Middlesboro South, Ky. - Tenn. - Va. 1974 (Photorevised 1991) 2. Middlesboro North, Ky. 1974

A.3.1 Tunnel Creek (TC10)

Stream Description:	Tunnel Creek , in the western end of the park, is a short stream about 0.6 miles long which flows west off of Cumberland Mountain to enter Little Yellow Creek between YC5 and YC5A (Figure A-2), the sampling stations upstream and downstream, respectively, from the confluence (Figure A-10). In its upper reaches, above the openings of the highway tunnels on the Kentucky side, it remains a small, wet-weather stream. Its lower reaches now flow continuously due to groundwater contributions from the tunnels. The lower portions of the stream contain several impoundments which are used during periods of tunnel construction to treat the discharge from the tunnels.
Watershed Description:	The Tunnel Creek watershed, which lies between the Davis Branch watershed to the north and the Little Yellow Creek watershed to the south (Figure A-1), has an area of about 0.25 square miles, all of which is located in the park. Historically, it has probably been affected by timbering. Currently, there do not appear to be any potential sources of stream contamination in the watershed other than construction activities on the tunnels.
Sampling Stations	TC10: Located at the last water treatment point on Tunnel Creek before it enters Little Yellow Creek (Figure A-2). Reportedly, pH fluctuations and high sediment loads eliminated or greatly reduced benthic macroinvertebrate populations here during periods of tunnel construction. TC10 was sampled daily during construction periods. It has been sampled twice weekly for a limited number of parameters since construction was halted in December, 1993, and regular water quality sampling is conducted twice per month and after storm events. Quarterly sediment samples were collected in 1993, and benthic macroinvertebrate samples were collected in at least the first two quarters.
Maps Reviewed:	U. S. G. S. 7.5-minute topographic quadrangles 1. Middlesboro South, Ky. - Tenn. -Va. 1974 (Photorevised 1991)

A.3 Miscellaneous Sampling Stations

A.3.1 KY18

Station KY18, located on a drainage ditch a short distance upstream from station YC5 (Figure A-2), was used to monitor an area which was once proposed for use as a staging area for construction machinery and materials. As it happened, the area was used only as a pipe storage area and as a parking area for three office trailers. The area, which in wet weather drains to Little Yellow Creek, was initially monitored for oil and grease, but monitoring was eventually discontinued. In 1993, one water sample was collected at KY18 on 3/23.

A.3.2 RR1

Station RR1 is used to monitor the quality of outflow from the Kentucky end of the existing railroad tunnel built in the 1800s (Figure A-2) . Dye tracer tests have not demonstrated a hydraulic connection between the existing tunnel and the highway tunnels which are presently under construction; however, the owner of a tannery which obtains its water from the railroad tunnel discharge says that his water supply has declined over the past several years. The portion of the flow that is not diverted enters Davis Branch about 150 yards upstream from its confluence with Little Yellow Creek. In 1993, water samples only were collected at RR1 at approximate two-week intervals and after storm events.

A.3.3 STOR1

Station STOR1, about one-half mile south of the intersection of U. S. 25E and U. S. 58 (Figure A-2), is located on a drainage ditch leading from a seep originating from an encapsulated spoil pile of low-pH shale. In 1993, samples of runoff from the pile were collected through 3/23 and one on 12/5. It does not appear to be located in an area which can affect any streams in the park.

A.3.4 TD1

Station TD1 is located on a small Gap Creek tributary (Figure A-2) which was demonstrated by dye tracer tests to be formed by the discharge from a cavern penetrated during the construction of the tunnel. The discharge emerges in an area which was used as a dump by residents of the town of Cumberland Gap. In 1993, water samples were collected from TD1 at approximate two-week intervals and after storm events, and sediment samples were collected quarterly.

A.3.5 988

Station 988 is located in Kentucky in a steep, rocky roadside drainage ditch near the junction of Hwy. 988 (Sugar Run Road) and U. S. 25E (Figure A-2). It is used to monitor runoff from a stockpile of excavated tunnel material. It is generally sampled only after storm

events. In 1993, four water samples were collected at 988 through 3/23 and one on 12/5.

A.3.6 CAVE

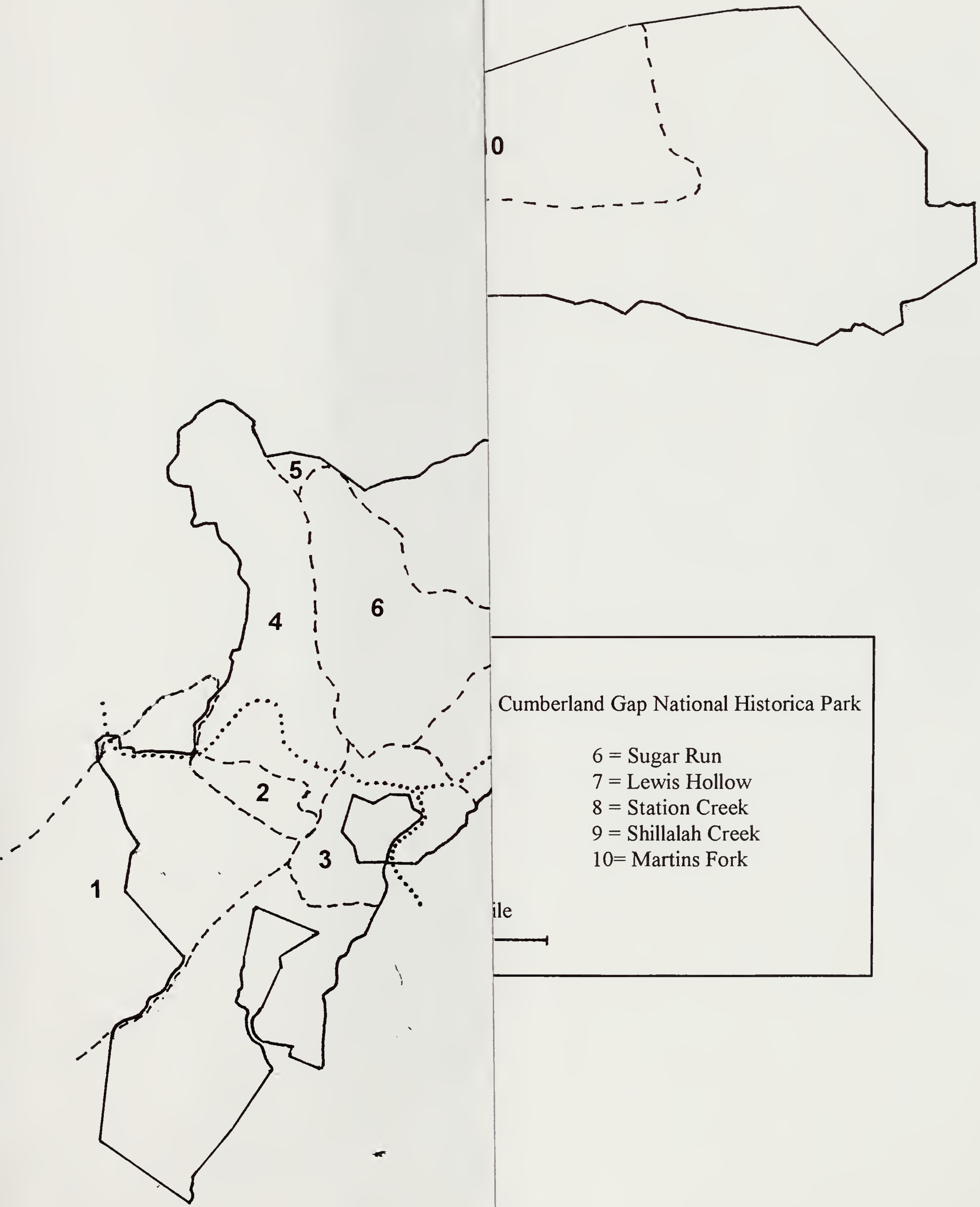
Station CAVE is located in the cavern which was penetrated during construction of the tunnels. It was sampled five times in 1993. Four of the samples were quarterly water- quality samples, and the fifth, collected on 12/5/93, was associated with a storm event.

A.3.7 CUDJO

Station CUDJO is located in Cudjo Cave (Figure A-2) on Cumberland Mountain in Virginia, which is the source of Gap Creek. One water sample was collected at this station on 6/26/93.

A.3.8 IF (Iron Furnace)

Station IF is located on Gap Creek above GC3 and adjacent to a historic iron furnace. One water sample was collected at this station on 3/23/93.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7 = Lewis Hollow
8 = Station Creek
9 = Shillalah Creek
10= Martins Fork
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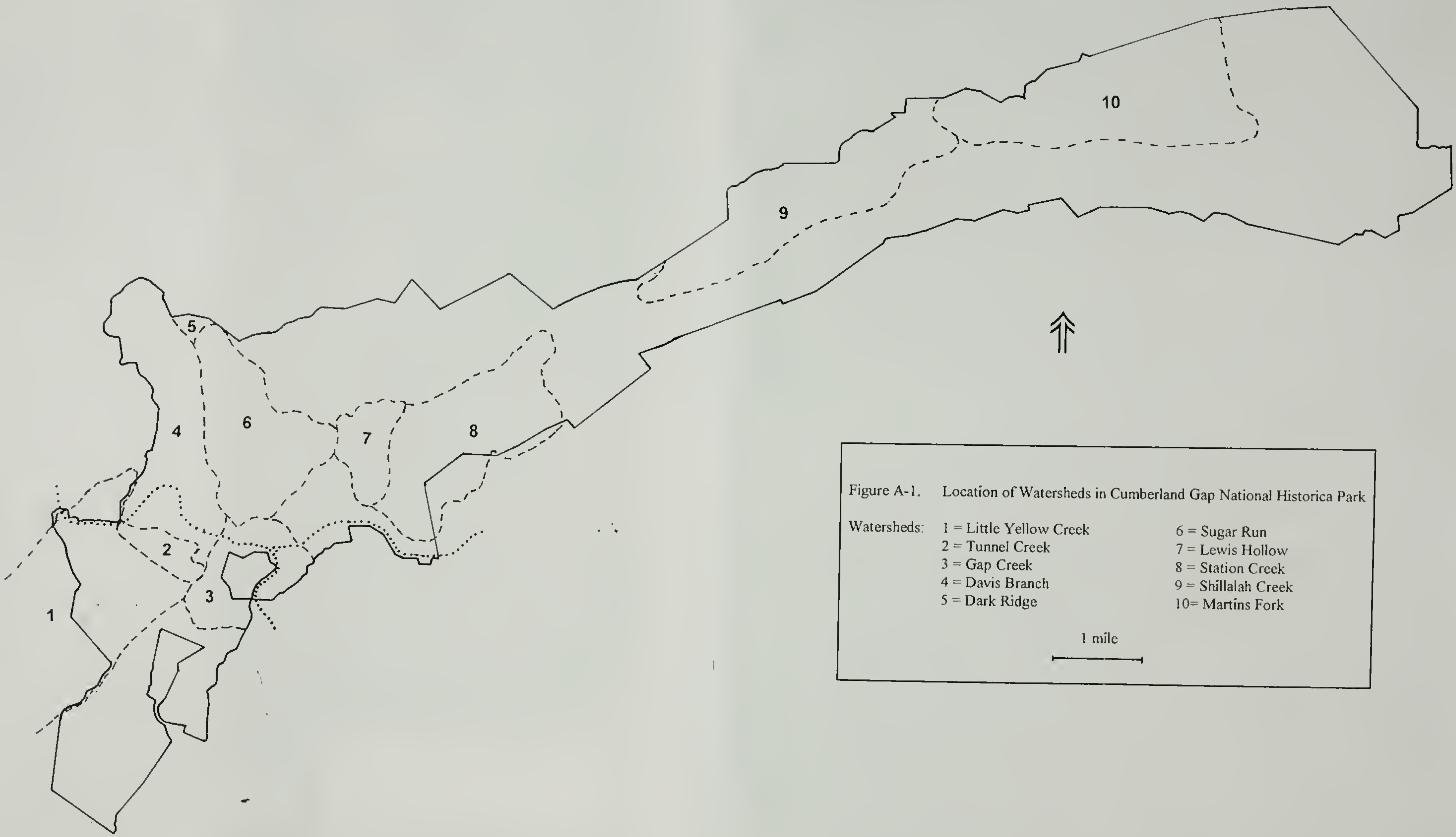
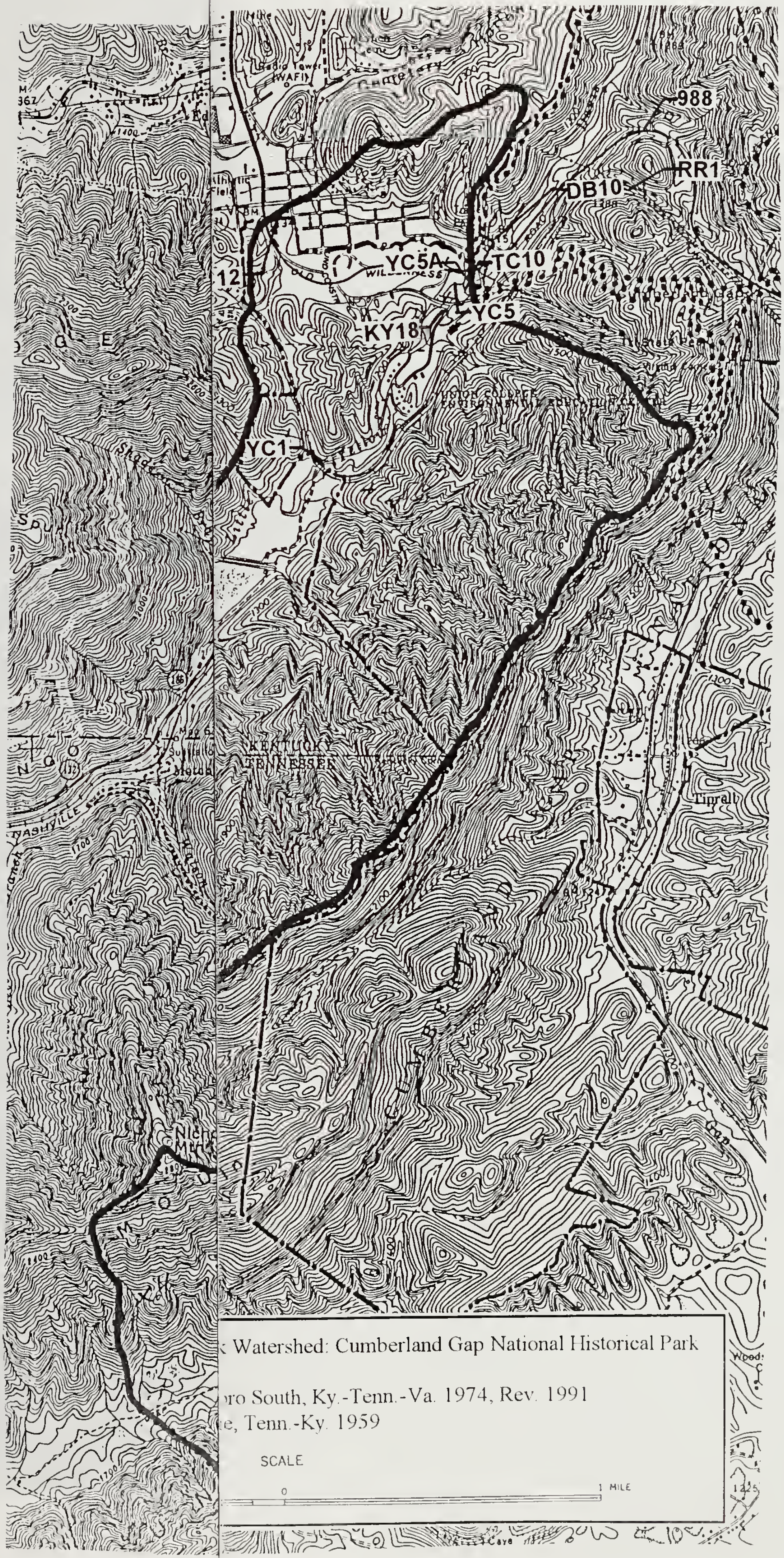


Figure A-1. Location of Watersheds in Cumberland Gap National Historica Park

Watersheds:
1 = Little Yellow Creek
2 = Tunnel Creek
3 = Gap Creek
4 = Davis Branch
5 = Dark Ridge
6 = Sugar Run
7 = Lewis Hollow
8 = Station Creek
9 = Shillalah Creek
10= Martins Fork



k Watershed: Cumberland Gap National Historical Park

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e, Tenn.-Ky. 1959

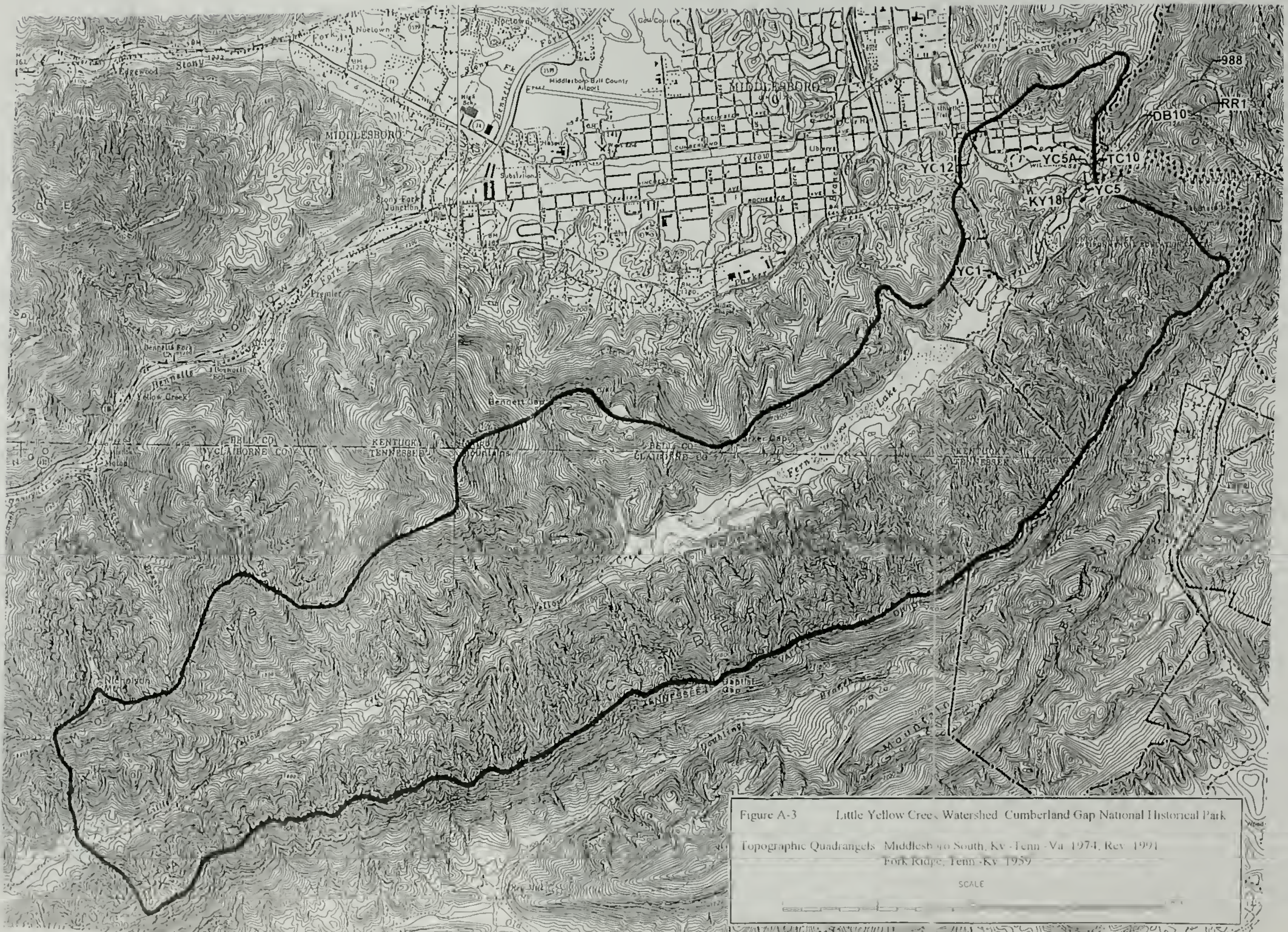
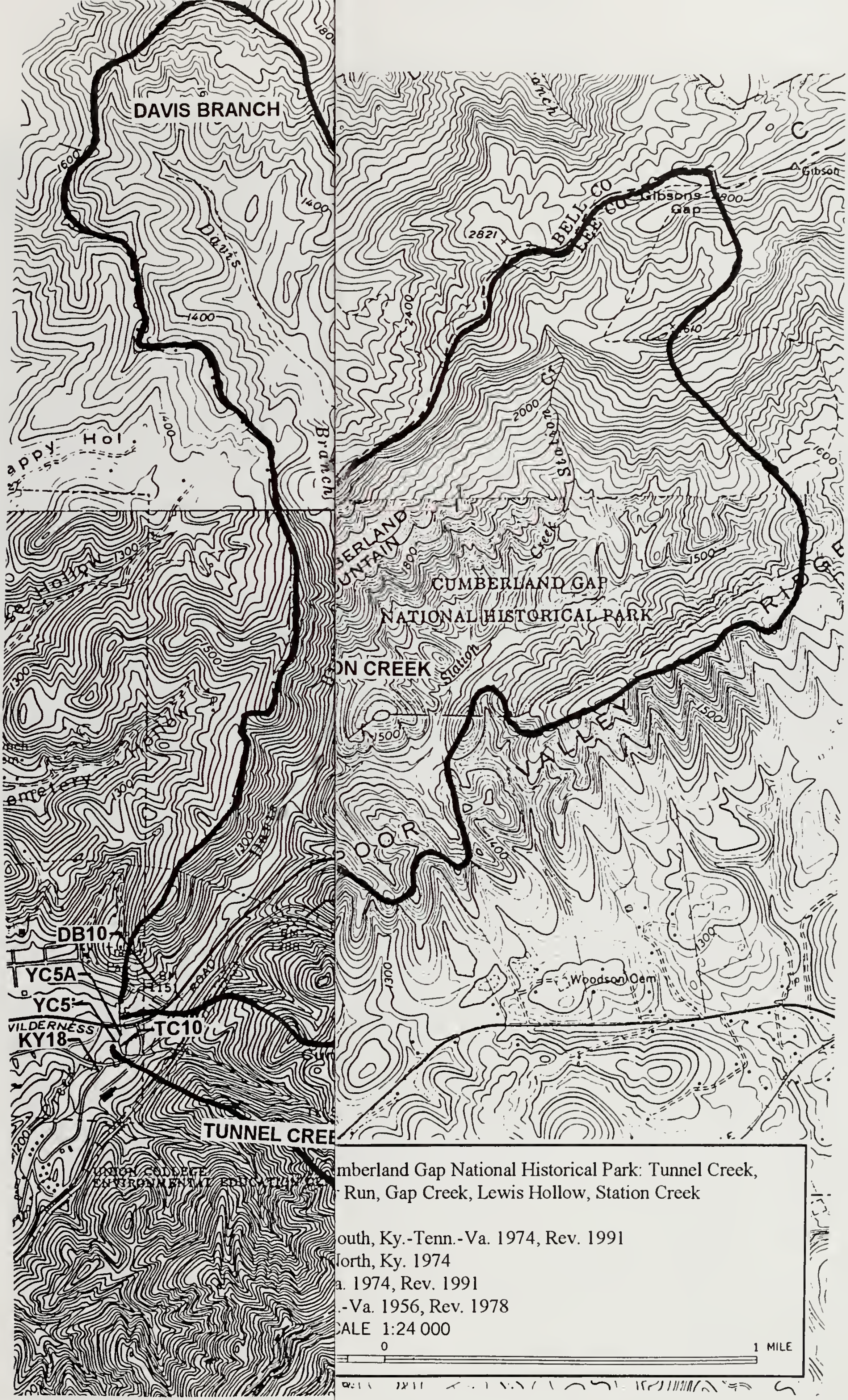


Figure A-3 Little Yellow Creek Watershed Cumberland Gap National Historical Park

Topographic Quadrangels Middlesboro South, Ky -Tenn -Va 1974, Rev 1991
Fork Ridge, Tenn -Ky 1959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Gibsons Gap
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Station Cr.
Station Creek
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NATIONAL HISTORICAL PARK
ON CREEK
POOR VALLEY RIDGE
Woodson Cem
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YC5A
YC5
TC10
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TUNNEL CREE
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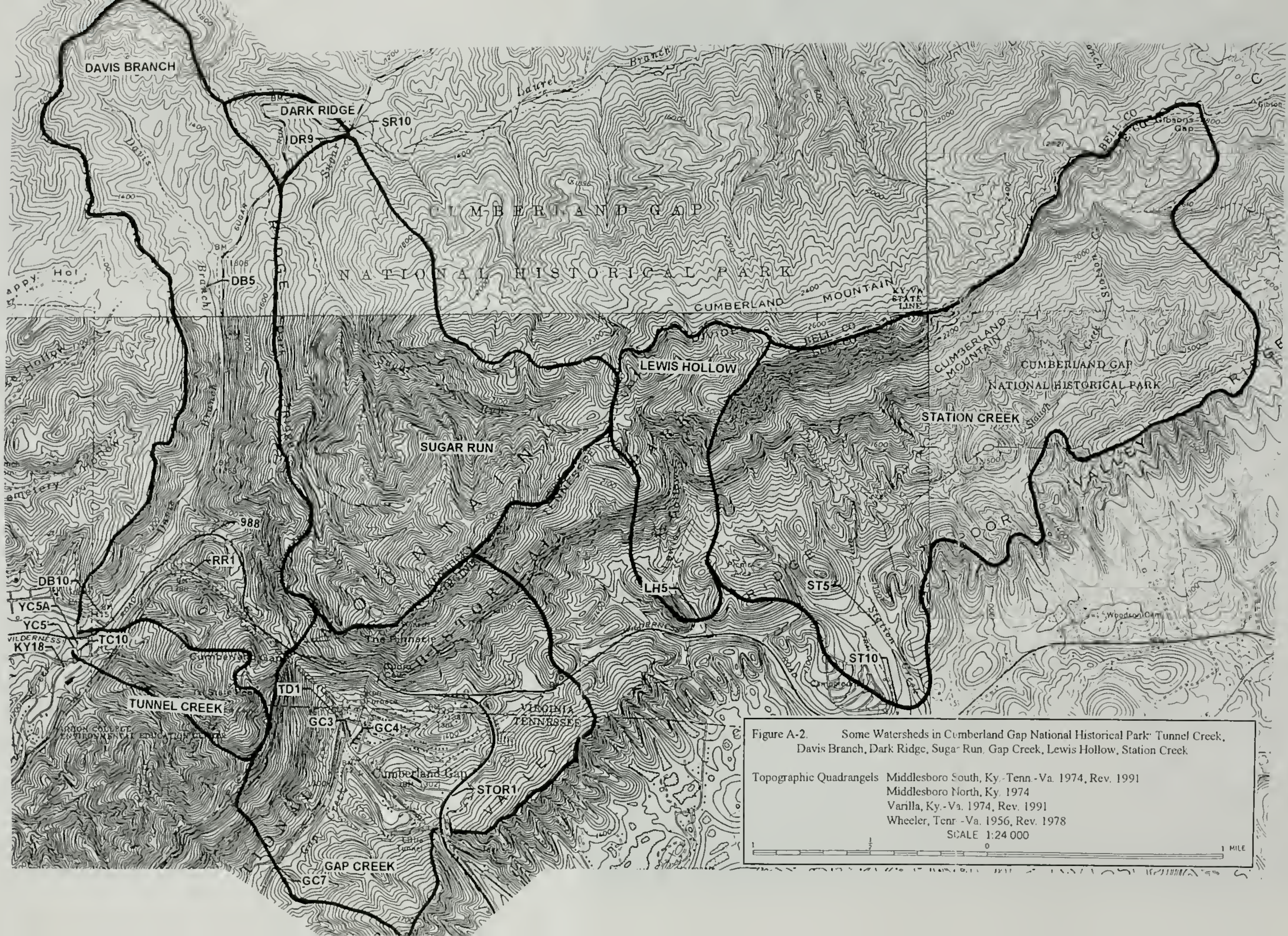

Figure A-2. Some Watersheds in Cumberland Gap National Historical Park: Tunnel Creek, Davis Branch, Dark Ridge, Sugar Run, Gap Creek, Lewis Hollow, Station Creek

Topographic Quadrangels Middlesboro South, Ky.-Tenn.-Va. 1974, Rev. 1991
Middlesboro North, Ky. 1974
Varilla, Ky.-Va. 1974, Rev. 1991
Wheeler, Tenn.-Va. 1956, Rev. 1978

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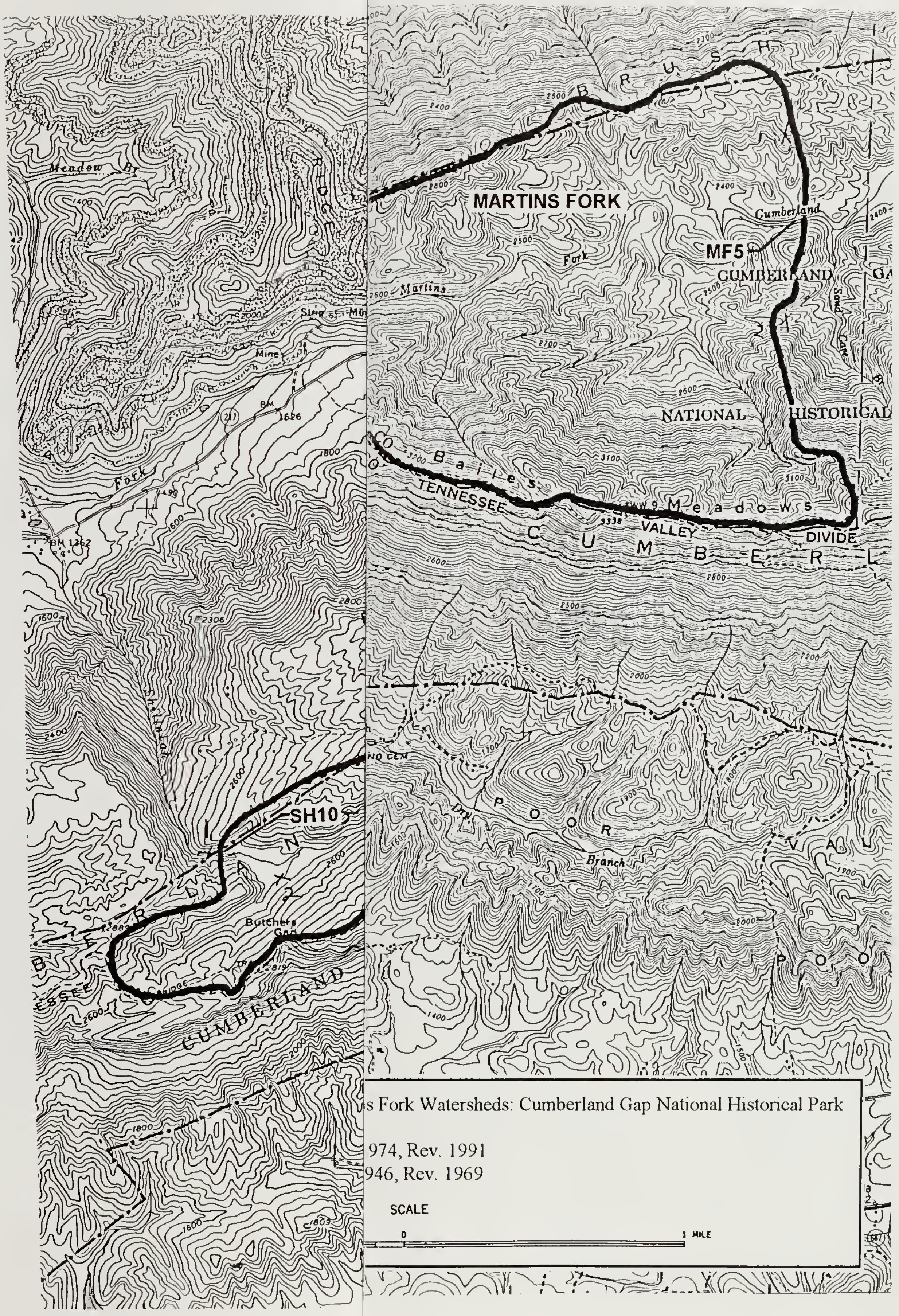

s Fork Watersheds: Cumberland Gap National Historical Park

974, Rev. 1991
946, Rev. 1969

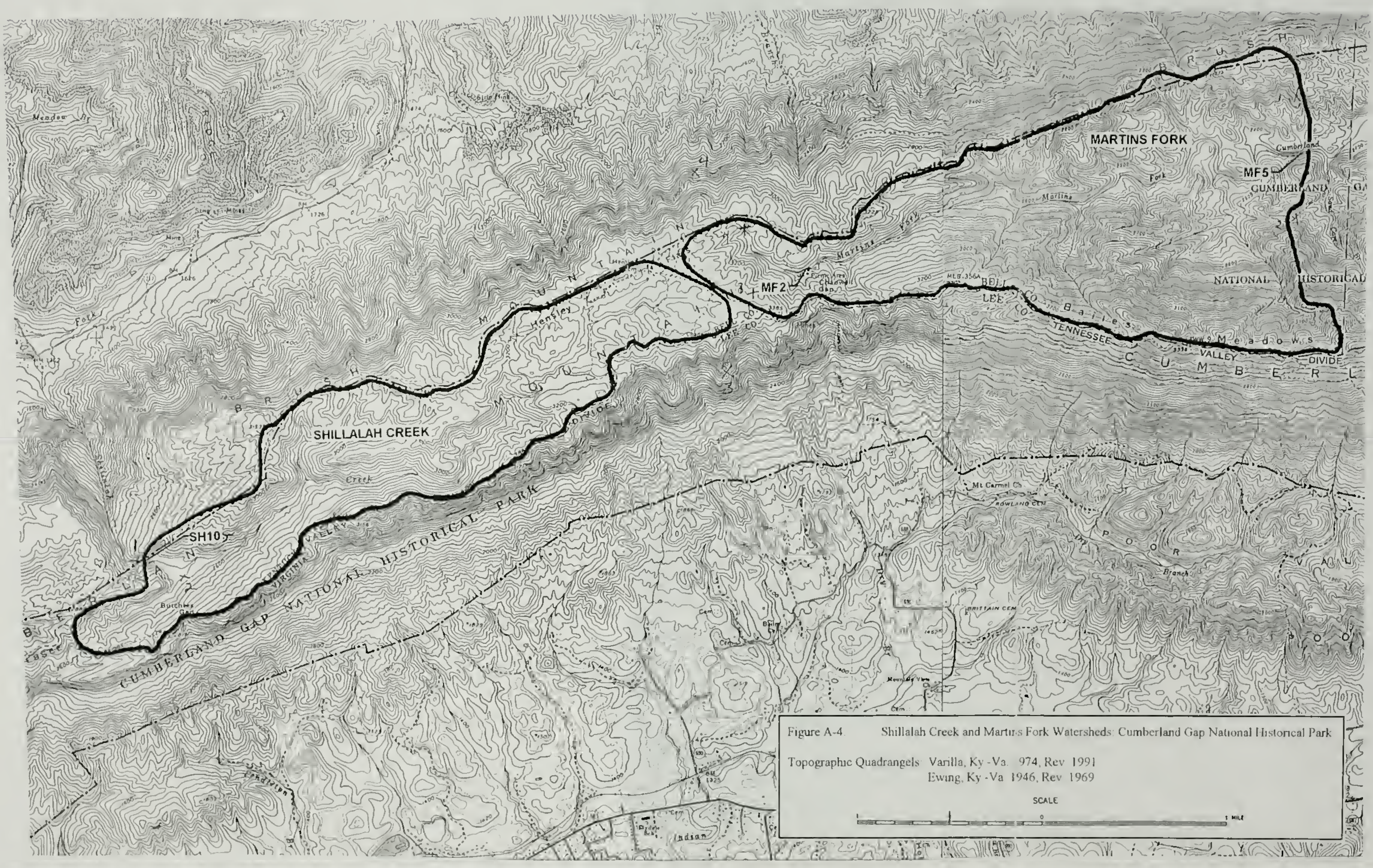

Figure A-4. Shillalah Creek and Martins Fork Watersheds: Cumberland Gap National Historical Park

Topographic Quadrangels: Varilla, Ky.-Va. 974, Rev. 1991
Ewing, Ky.-Va. 1946, Rev. 1969

SCALE

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Appendix B

1993 Water Quality Data

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* In the tabulated data, a lower case "s" after a station designates a sample that was collected in association with a storm event (e.g. YC5s).

Station CAVE Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
CAVE	2/22/93	1310	12.5	7.7	7.1	67		229	464	120.00	130	130	10		11.0	<0.1	
CAVE	7/6/93	1415	15.0	7.8	7.3	bdl	0.80	122	437	25.00	60	70	10		56.0	bdl	
CAVE	11/28/93	1155	13.4	7.8	9.2	bdl	0.45	307	496	47.60	160	160	10		140.0	bdl	
CAVEs	12/5/93	0808	13.7	7.7	8.6	bdl	3.20	254	547	22.00	140	134	40		110.0	bdl	5.20
CAVE	12/12/93	1340	13.4	7.7	9.0	bdl	0.61	247	513	7.60	130	131	10	bdl	110.0	bdl	bdl

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
CAVE	2/22/93	46.37	3.20	0.80	1.00	2.63	9.10	1.07	<0.02	1.60	6.71		2.47	0.94	<0.1	<0.1	<0.3	
CAVE	7/6/93	21.40	1.60	0.80	1.00	1.28	4.40	0.39	bdl	6.40	34.16		1.40	1.09	bdl	bdl	bdl	
CAVE	11/28/93	55.90	5.00	1.10	1.00	3.26	10.00	1.00	bdl	1.50	85.40		3.08	0.94	0.30	bdl	bdl	
CAVEs	12/5/93	50.00	2.70	0.42	0.80	2.76	11.00	1.10	bdl	1.30	67.10		2.49		0.10	bdl	bdl	bdl
CAVE	12/12/93	47.00	2.70	0.40	0.90	2.62	11.00	1.10	bdl	1.30	67.10		2.48	0.95	0.20	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
CAVE	2/22/93	0.04	<0.01			<0.01	<0.01	<0.01		<0.01		<0.01	<0.1	<0.1	2.6		<0.01		0.01	2.4	0.06	1.8
CAVE	7/6/93	0.18	bdl			bdl	0.01	0.11		bdl		bdl	bdl	bdl	3.8		bdl		bdl	0.11	0.02	0.89
CAVE	11/28/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl			bdl		0.07	0.07	0.01	0.12
CAVEs	12/5/93	0.12	bdl	0.02	bdl	bdl	bdl	0.09	0.9	bdl	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.27	0.01	0.52
CAVE	12/12/93	0.15	bdl	bdl	bdl	bdl	bdl	0.09	bdl	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.09	bdl	0.16

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
DB5	1/11/93	1530	9.1	7.6	8.7	18	2.20	61	504	5.80	14	22	25		8.5	<0.1	
DB5	1/25/93	1405	7.3	7.5	9.3	10	2.40	39	389	8.80	13	19	15		7.8	<0.1	
DB5	2/8/93	1350	6.1	7.1	10.6	4	0.49	47	436	<0.01	17	21	15	<0.01	11.0	<0.1	
DB5	2/22/93	1130	7.0	7.8	9.0	17	5.40	30	371	12.70	12	17	20		4.3	<0.1	
DB5	3/8/93	1300	8.8	7.4	9.1	8	1.40	34	497	3.30	13	22	15		9.0		
DB5	3/22/93	1355	10.0	6.3	8.7	8	4.80	35	499	11.00	12	18	15		3.9	bdl	
DB5s	3/23/93	1410	8.2	7.3	9.0	200		29	464	221.00	9	17	40		2.2	bdl	11.00
DB5	4/2/93	1320	6.9	7.1	9.4	9	1.40	40	422	10.20	13	23	10		6.3	bdl	
DB5	4/19/93	1304	14.1	6.8	7.8	7	0.80	36	486	4.20	14	23	15		8.5	bdl	
DB5	5/3/93	1110	13.9	7.6	6.5	6	0.54	6	436	3.30	16	24	15		10.0	bdl	
DB5	5/17/93	1305	16.5	7.0	6.7	7	0.13	48	525	5.70	21	31	30		20.0	bdl	
DB5	5/31/93	1320	17.4	7.1	6.7	10	0.07	86	448	8.70	25	35	40		21.0		
DB5	6/14/93	1105	18.2	6.5	5.0	12	0.07	81	434	7.00	29	37	40		24.0	bdl	
DB5	7/6/93	1520	22.0	8.1	1.3	9		90	464	6.60	28	47	30		33.0	bdl	
DB5	7/19/93	1455	22.9	6.6	5.3	17		85	449	11.10	35	41	35		29.0	bdl	
DB5	8/23/93	1515	21.8	7.3	3.5	6		93	488	3.50	39	46	40	bdl	32.0	bdl	
DB5	9/7/93	1502	19.3	6.3	1.7	7		114	520	5.20	38	45	60		31.0	bdl	
DB5s	12/5/93	0957	10.1	6.1	9.4	bdl	10.40	40	520	32.90	13	18	30	bdl	4.7	bdl	2.20

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
DB5	1/11/93	2.55	1.90	1.30	0.90	0.37	7.80	0.55	<0.02	1.80	5.19		0.39	1.06	<0.1	<0.1	<0.3	
DB5	1/25/93	2.24	1.70	1.10	0.80		6.80	0.36	<0.02	0.90	4.76			1.05	<0.1	<0.1	<0.3	
DB5	2/8/93	3.20	2.30	1.20	0.90		5.80	<0.05	<0.02	1.00	6.71			0.85	<0.1	<0.1	<0.3	
DB5	2/22/93	1.98	1.60	1.00	0.90	0.31	7.30	0.34	<0.02	1.10	2.62		0.27	0.90	<0.1	<0.1	<0.3	
DB5	3/8/93	2.40	1.70	1.30	0.70	0.34	7.80	1.90		0.80	5.49		0.40	1.15				
DB5	3/22/93	2.24	1.60	1.10	0.80	0.32	8.90	bdl	bdl	1.30	17.69		0.30	0.94	bdl	bdl	bdl	
DB5s	3/23/93	1.70	1.10	0.49	1.00	0.26	10.00	bdl	bdl	0.80	1.34		0.27	1.06	bdl	bdl	bdl	
DB5	4/2/93	2.37	1.80	1.10	0.80	0.34	10.00	0.34	2.10	0.90	3.84		0.41	1.20	bdl	bdl	bdl	
DB5	4/19/93	2.43	1.80	1.20	0.90	0.35	9.90	0.33	2.00	1.00	5.19		0.41	1.18	bdl	bdl	bdl	
DB5	5/3/93	3.09	2.10	1.20	0.80	0.40	9.00	bdl	0.91	0.80	6.10		0.43	1.07	bdl	bdl	bdl	
DB5	5/17/93	4.46	2.50	1.40	1.10	0.53	7.50	0.38	0.56	0.90	12.20		0.60	1.13	bdl	bdl	bdl	
DB5	5/31/93	5.40	2.80	1.50	1.20	0.61	6.60	2.70	0.68	1.20	12.81		0.65	1.06	bdl		bdl	
DB5	6/14/93	6.08	3.30	1.60	1.40	0.70	7.00	1.20	0.33	1.10	14.64		0.68	0.97	bdl	bdl	bdl	
DB5	7/6/93	8.00	4.10	1.70	1.70	0.89	7.20	1.20	1.40	1.00	20.13		0.89	1.00	bdl	bdl	bdl	
DB5	7/19/93	8.07	3.60	1.60	1.70	0.84	5.30	1.30	bdl	0.90	17.69		0.74	0.88	bdl	bdl	bdl	
DB5	8/23/93	8.81	4.00	1.70	2.20	0.92	7.60	0.55	bdl	1.00	19.52		0.84	0.92	0.10	bdl	bdl	
DB5	9/7/93	8.90	3.80	1.50	2.60	0.92	6.60	0.40	bdl	1.40	18.91		0.81	0.88	0.10	bdl	bdl	
DB5s	12/5/93	2.50	1.60	0.80	1.10	0.35	7.70	0.21	bdl	1.00	2.87		0.29		bdl	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DB5	1/11/93	<0.01	<0.01			<0.01	<0.01	0.15		0.04		<0.01	0.10	<0.1	3.60		<0.01		<0.01	0.42	0.05	0.03
DB5	1/25/93	0.02	<0.01			<0.01	<0.01	0.15		0.03		<0.01	<0.1	<0.1	3.50		<0.01		<0.01	0.32	0.03	0.19
DB5	2/8/93	<0.01	<0.01			<0.01	<0.01	0.20		0.06		<0.01	<0.1	<0.1	3.40		3.00		4.20	0.56	0.06	0.05
DB5	2/22/93	0.04	<0.01			<0.01	<0.01	0.13		0.01		<0.01	<0.1	<0.1	3.30		0.02		<0.01	0.29	0.01	0.54
DB5	3/8/93	0.03						0.18		0.03		0.01			3.30		bdl			0.31	0.03	0.03
DB5	3/22/93	0.04	bdl			bdl	bdl	0.09		0.02		bdl	bdl	bdl	3.50		bdl		bdl	0.21	0.02	0.04
DB5s	3/23/93	0.26	bdl	0.01		bdl	0.01	0.20		0.06		0.01	bdl	bdl	1.90	bdl	0.06	bdl	0.02	1.10	0.19	0.52
DB5	4/2/93	0.02	bdl			bdl	bdl	0.15		0.03		bdl	bdl	bdl	3.30		0.01		bdl	0.17	0.03	0.02
DB5	4/19/93	0.03	bdl			bdl	bdl	0.04		0.03		bdl	bdl	bdl	3.30		bdl		bdl	0.29	0.03	0.09
DB5	5/3/93	bdl	bdl			bdl	bdl	0.08		0.04		bdl	bdl	bdl	3.50		bdl		0.02	0.28	0.05	0.05
DB5	5/17/93	0.03	bdl			bdl	bdl	0.32		0.07		bdl	bdl	bdl	3.70		bdl		0.02	0.69	0.07	0.06
DB5	5/31/93	0.01				0.01	bdl	0.41		0.10		bdl	bdl	bdl	3.70		bdl		0.04	1.10	bdl	0.16
DB5	6/14/93	0.02	bdl			bdl	bdl	0.54		0.07		bdl	bdl	bdl	4.10		bdl		0.03	1.00	0.08	0.05
DB5	7/6/93	0.03	bdl			bdl	0.02	0.73		0.24		bdl	bdl	bdl	3.90		bdl		bdl	1.70	0.25	0.07
DB5	7/19/93	0.02	0.02			bdl	0.01	0.73		0.09		bdl	bdl	bdl	3.60		bdl		bdl	1.10	0.10	0.07
DB5	8/23/93	0.02	bdl			bdl	bdl	0.43		0.13		bdl	bdl	bdl	3.70		bdl		bdl	1.00	0.13	0.12
DB5	9/7/93	0.01	bdl			bdl	bdl	0.66		0.16		bdl	bdl	bdl	2.90		bdl		bdl	1.50	0.17	0.08
DB5s	12/5/93	0.17	bdl	0.02	bdl	bdl	bdl	0.18	0.83	0.04	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.46	0.05	0.41

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Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
DB10	1/11/93	1105	8.8	7.0	9.2	4	2.20	77	501	1.50	27	39	10	0.60	17.0	<0.1	
DB10	1/25/93	1315	6.3	7.7	10.4	8	4.10	68	396	6.60	23	36	15		14.0	<0.1	
DB10	2/8/93	1415	7.0	7.2	9.7	1	0.49	104	449	0.80	34	50	15	3.00	24.0	<0.1	
DB10	2/22/93	1215	7.5	7.4	9.0	11	9.60	57	451	10.40	22	bdl	15		12.0	<0.1	
DB10	3/8/93	1440	9.0	7.3	8.9	6	2.90	79	469	1.80	29	52	10	bdl	19.0		
DB10	3/22/93	1330	9.2	6.8	8.7	7	6.70	78	494	8.80	24	41	15		10.0	bdl	
DB10s	3/23/93	1350	8.8	7.8	7.6	200		53	457	670.00	18	30	40	bdl	13.0	bdl	12.00
DB10	4/2/93	1115	7.4	7.2	9.3	6	2.60	94	409	8.30	30	50	5		17.0	bdl	
DB10	4/19/93	1221	13.8	7.1	7.7	5	1.40	73	506	4.70	28	46	15	bdl	17.0	bdl	
DB10	5/3/93	1450	14.6	7.2	7.6	5	1.00	82	488	2.40	34	49	5		23.0	bdl	
DB10	5/17/93	1110	15.9	7.3	6.5	3	0.28	116	480	2.50	52	75	20		43.0	bdl	
DB10	5/31/93	1035	17.3	7.4	5.1	3	0.10	188	380	3.00	65	90	20		53.0	bdl	
DB10	6/14/93	1045	18.7	6.8	5.8	5	0.20	214	398	4.10	85	103	20		69.0	bdl	
DB10	7/6/93	1450	25.5	8.0	4.3	9	0.06	252	438	4.70	110	136	5		90.0	bdl	
DB10	7/19/93	1110	22.2	7.6	5.8	5	0.10	247	377	2.80	96	127	20		78.0	bdl	
DB10	8/9/93	1438	21.9	7.7	6.8	4	0.01	307	360	4.00	130	163	15	bdl	110.0	bdl	
DB10	8/23/93	1535	25.1	7.9	5.4	4	0.10	271	461	2.10	110	152	10	bdl	91.0	bdl	
DB10	9/7/93	1434	22.3	7.3	6.0	3		303	488	3.30	120	153	20		100.0	bdl	
DB10	9/21/93	1010	18.2	7.6	4.9	5	0.25	299	425	3.20	140	160	20		100.0	bdl	
DB10	10/7/93	1017	13.6	7.4	5.4	3	0.23	315	422	2.00	130	161	15		100.0	bdl	
DB10	10/18/93	1110	15.4	7.3	4.4	1	0.43	289	493	1.70	120	170	25	bdl	110.0	bdl	
DB10	11/4/93	1201	9.6	7.4	8.1	2		226	449	3.20	85	112	25		62.0	bdl	
DB10	11/15/93	1042	14.3	7.2	6.8	bdl	0.25	253	447	2.00	97	133	20		66.0	bdl	
DB10	11/29/93	1522	7.2	7.3	10.3	bdl		166	409	1.40	61	86	15		37.0	bdl	
DB10s	12/5/93	0939	10.2	7.0	9.6	bdl		79	494	20.50	29	40	20		13.0	bdl	2.30
DB10	12/13/93	1103	4.0	7.1	11.3	bdl	0.87	116	380	0.50	42	59	10	0.05	24.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
DB10	1/11/93	7.25	2.20	2.80	1.00	0.69	11.00	0.64	<0.02	3.30	10.37		0.67	0.97	<0.1	<0.1	<0.3	
DB10	1/25/93	6.23	1.90	2.40	1.00		9.70	3.52	<0.02	2.10	8.54			1.02	<0.1	<0.1	<0.3	
DB10	2/8/93	9.85	2.40	3.30	1.00		12.00	3.11	<0.02	3.50	14.64			1.02	<0.1	<0.1	<0.3	
DB10	2/22/93	5.89	1.90	<0.01	0.80	0.58	35.10	<0.1	0.98	3.80	7.32		0.61	1.06	<0.1	<0.1	<0.1	
DB10	3/8/93	8.31	2.00	5.20	0.90	0.83	13.00	2.50		8.40	11.59		0.93	1.11				
DB10	3/22/93	6.72	1.80	4.00	0.80	0.68	13.00	0.55	bdl	7.80	2.38		0.70	1.03	bdl	bdl	bdl	
DB10s	3/23/93	4.90	1.30	1.40	1.40	0.49	9.50	1.10	bdl	1.90	7.93		0.53	1.08	bdl	bdl	bdl	
DB10	4/2/93	8.35	2.10	4.60	1.40	0.83	14.00	0.67	0.83	7.20	10.37		0.86	1.04	bdl	bdl	bdl	
DB10	4/19/93	8.05	2.00	3.60	0.90	0.75	14.00	0.97	0.86	5.60	10.37		0.82	1.20	bdl	bdl	bdl	
DB10	5/3/93	9.92	2.00	3.90	0.50	0.88	12.00	0.37	0.42	5.60	14.03		0.88	1.00	bdl	bdl	bdl	
DB10	5/17/93	15.90	2.90	4.80	1.20	1.28	14.00	0.88	1.10	8.00	26.23		1.42	1.11	bdl	bdl	bdl	
DB10	5/31/93	20.90	3.20	6.50	1.40	1.63	14.00	1.00	1.00	10.00	32.33		1.67	1.02	bdl	bdl	bdl	
DB10	6/14/93	27.70	3.90	6.50	1.60	2.04	12.00	bdl	bdl	9.90	42.09		1.91	0.94	bdl	bdl	bdl	
DB10	7/6/93	35.20	4.70	8.00	2.10	2.55	17.00	1.70	bdl	13.00	54.90		2.55	1.00	bdl	bdl	bdl	
DB10	7/19/93	32.30	3.80	8.80	1.80	2.37	19.00	1.30	bdl	13.00	47.58		2.34	0.99	bdl	bdl	bdl	
DB10	8/9/93	43.40	5.20	12.00	2.00	3.17	17.00	0.59	bdl	17.00	67.10		3.04	0.96	bdl	bdl	bdl	
DB10	8/23/93	37.10	4.40	21.00	2.30	3.19	18.00	0.48	bdl	14.00	55.51		2.61	0.82	0.20	bdl	bdl	
DB10	9/7/93	41.30	5.00	12.00	1.90	3.05	17.00	0.38	bdl	15.00	61.00		2.79	0.92	0.20	bdl	bdl	
DB10	9/21/93	46.30	5.10	11.00	2.30	3.27	18.00	0.34	bdl	16.00	61.00		2.84	0.87	0.20	bdl	bdl	
DB10	10/7/93	42.60	5.20	12.00	2.30	3.15	20.00	bdl	bdl	18.00	61.00		2.93	0.93	0.20	bdl	bdl	
DB10	10/18/93	40.30	5.00	18.00	2.90	3.28	20.00	bdl	bdl	18.00	67.10		3.12	0.95	bdl	bdl	bdl	
DB10	11/4/93	27.60	3.90	9.40	2.60	2.18	17.00	0.50	bdl	13.00	37.82		1.98	0.91	0.20	bdl	bdl	
DB10	11/15/93	31.60	4.40	12.00	3.20	2.55	26.00	0.16	bdl	16.00	40.26		2.33	0.91	0.20	bdl	bdl	
DB10	11/29/93	18.60	3.50	7.60	1.60	1.59	21.00	0.54	bdl	10.00	22.57		1.48	0.93	0.20	bdl	bdl	
DB10s	12/5/93	8.40	1.90	2.30	0.97	0.72	1.40	0.89	bdl	3.10	7.93		0.66		0.10	bdl	bdl	bdl
DB10	12/13/93	12.60	2.60	4.50	1.20	1.08	17.00	0.49	bdl	6.00	14.64		1.02	0.95	0.10	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DB10	1/11/93	<0.01	<0.01			<0.01	<0.01	0.11		0.03		<0.01	<0.1	<0.1	3.30		<0.01		<0.01	0.37	0.03	<0.01
DB10	1/25/93	0.01	<0.01			<0.01	0.02	0.10		0.02		<0.01	<0.1	<0.1	3.10		<0.01		<0.01	0.24	0.03	0.11
DB10	2/8/93	<0.01	<0.01			<0.01	<0.01	0.18		0.04		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.29	0.04	<0.01
DB10	2/22/93	<0.01	<0.01			<0.01	<0.01	0.06		0.01		<0.02	2.90	<0.3	12.00		0.10		<0.01	0.27	0.01	<0.28
DB10	3/8/93	0.03						0.12		0.02					2.80					0.21	0.02	0.07
DB10	3/22/93	0.02	bdl			bdl	bdl	0.06		0.01		bdl	bdl	bdl	3.00		bdl		bdl	0.17	0.02	0.11
DB10s	3/23/93	0.25	bdl	0.02		bdl	bdl	0.31		0.08		bdl	bdl	bdl	2.10	0.01	bdl	bdl	0.02	3.50	0.55	1.60
DB10	4/2/93	0.01	bdl			bdl	bdl	0.08		0.02		bdl	bdl	bdl	2.90		bdl		0.01	0.11	0.02	0.01
DB10	4/19/93	bdl	bdl			bdl	bdl	0.10		0.02		bdl	bdl	bdl	2.80		bdl		bdl	0.24	0.02	0.11
DB10	5/3/93	0.02	bdl			bdl	0.01	0.08		bdl		bdl	bdl	bdl	2.90		bdl		0.01	0.21	bdl	0.03
DB10	5/17/93	bdl	bdl			bdl	bdl	0.23		0.05		bdl	bdl	bdl	3.00		bdl		0.01	0.36	0.05	0.05
DB10	5/31/93	bdl	bdl			bdl	bdl	0.31		0.07		bdl	bdl	bdl	2.90		bdl		0.04	0.51	0.08	0.89
DB10	6/14/93	bdl	bdl			bdl	bdl	0.33		0.07		bdl	bdl	bdl	3.40		bdl		0.04	0.58	0.07	0.02
DB10	7/6/93	0.01	bdl			bdl	0.01	0.30		0.10		bdl	bdl	bdl	3.80		bdl		0.01	0.56	0.11	0.03
DB10	7/19/93	0.02	bdl			bdl	bdl	0.40		0.07		0.01	bdl	bdl	3.10		bdl		bdl	0.55	0.07	0.03
DB10	8/9/93	bdl	0.02			bdl	bdl	0.16		0.09		bdl	bdl	bdl	3.20		bdl		bdl	0.75	0.10	0.02
DB10	8/23/93	bdl	0.02			bdl	bdl	0.32		0.05		bdl	bdl	bdl	3.40		bdl		bdl	0.48	0.05	0.01
DB10	9/7/93	bdl	0.02			bdl	bdl	0.29		0.08		bdl	bdl	bdl	3.30		bdl		bdl	0.59	0.08	0.02
DB10	9/21/93	bdl	0.01			bdl	0.02	0.20		0.06		bdl	bdl	bdl	3.10		bdl		0.01			bdl
DB10	10/7/93	bdl	bdl			bdl	bdl	0.24		0.03		bdl	bdl	bdl	2.90		bdl		0.02	0.73	0.04	bdl
DB10	10/18/93	bdl	0.01			bdl	bdl	0.24		0.02		bdl	bdl	bdl	3.10		bdl		0.01	0.34	0.02	bdl
DB10	11/4/93	bdl	0.02			bdl	bdl	0.29		0.01		bdl	0.10	bdl	3.00		bdl		0.02	0.39	0.02	0.02
DB10	11/15/93	bdl	bdl			bdl	bdl	0.22		0.02		bdl	bdl	bdl	3.00		bdl		0.03	0.34	0.03	0.02
DB10	11/29/93	0.01	bdl			bdl	bdl	0.19		0.04		bdl	bdl	bdl			bdl		bdl	0.30	0.04	0.04
DB10s	12/5/93	0.14	bdl	0.02	bdl	bdl	0.02	0.12	0.92	0.03	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.32	0.04	0.24
DB10	12/13/93	bdl	bdl	bdl	bdl	bdl	bdl	0.19	bdl	0.04	bdl	bdl	bdl				bdl	bdl	0.01	0.27	0.05	bdl

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
GC3	1/11/93	1425	11.6	7.4	8.6	6	7.30	124	520	0.80	59	63	5		49.0	<0.1	
GC3	1/25/93	1440	11.4	7.9	8.9	2	9.90	128	425	3.00	62	67	<5		52.0	<0.1	
GC3	2/8/93	1310	12.1	8.0	8.5	2	2.60	140	467	5.20	64	69	10		57.0	<0.1	
GC3	2/22/93	0955	11.5		8.5	7	20.10	126	485	9.10	68	71	15		53.0	<0.1	
GC3	3/8/93	1045	11.6	7.8	8.7	3	7.80	114	482	2.00	55	66	10		54.0		
GC3	3/22/93	1430	0.2	7.7	8.7	5	17.00	120	425	4.40	58	63	15		48.0	bdl	
GC3s	3/23/93	1450	11.9	7.6	8.7	200		134	434	138.00	63	79	30		58.0	bdl	8.00
GC3	4/2/93	1350	10.8	7.4	8.9	4	8.70	127	402	6.80	59	64	5		51.0	bdl	
GC3	4/19/93	1344	13.2	7.9	8.2	2	4.60	104	439	2.80	60	67	10		54.0	bdl	
GC3	5/3/93	1020	12.5	8.0	8.0	2	3.70	110	492	1.80	64	69	5		56.0	bdl	
GC3	5/17/93	1400	13.8	8.1	7.3	1	2.30	125	448	0.80	68	77	5		64.0	bdl	
GC3	5/31/93	1400	13.3	7.9	9.2	1	0.60	161	331	2.20	72	79	10		67.0	bdl	
GC3	6/14/93	1320	15.0	8.0	8.1	3	1.60	155	378	2.00	79	82	5		71.0	bdl	
GC3	7/6/93	1050	16.6	8.0	5.7	3	0.40	181	366	3.60	93	96	5		84.0	bdl	
GC3	7/19/93	1535	17.7	8.0	8.4	7	0.30	202	392	11.90	98	102	10		89.0	bdl	
GC3	8/9/93	1133	16.6	8.2	10.0	2	0.53	193	343	3.80	100	105	10	bdl	91.0	bdl	
GC3	8/23/93	1415	20.0	8.3	8.3	2	0.45	172	411	1.80	100	105	10	bdl	91.0	bdl	
GC3	9/7/93	1540	19.3	7.8	6.8	2		199	433	3.70	100	92	10		70.0	bdl	
GC3	9/21/93	1103	16.8	8.1	6.9	2	0.23	209	415	2.20	120	112	bdl		92.0	bdl	
GC3	11/29/93	0833	11.0	7.8	9.8	bdl		95	506	1.80	44	37	10		30.0	bdl	
GC3s	12/5/93	1017	12.0	7.9	9.6	bdl		118	466	38.30	60	62	5	bdl	41.0	bdl	1.60
GC3	12/13/93	1300	11.7	7.8	9.5	bdl	4.80	103	455	4.80	49	51	10	bdl	35.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
GC3	1/11/93	20.26	2.10	1.20	0.70	1.25	7.50	1.00	<0.02	1.20	29.89		1.19	0.95	<0.1	<0.1	<0.3	
GC3	1/25/93	21.18	2.20	0.70	0.60		8.10	1.08	<0.02	1.00	31.72			1.00	<0.1	<0.1	<0.3	
GC3	2/8/93	21.75	2.30	0.70	0.90		6.70	1.04	<0.02	1.10	34.77			1.00	<0.1	<0.1	<0.3	
GC3	2/22/93	23.27	2.30	1.00	0.80	1.41	8.00	1.90	<0.02	1.40	32.23		1.30		<0.1	<0.1	<0.3	
GC3	3/8/93	19.10	1.90	0.80	0.80	1.16	7.70	1.50		1.70	32.94		1.31	1.13				
GC3	3/22/93	20.10	1.90	0.70	0.60	1.20	8.50	1.40	bdl	1.20	6.10		1.19	0.99	bdl	bdl	bdl	
GC3s	3/23/93	22.00	1.90	0.79	1.60	1.36	13.00	2.70	bdl	2.00	35.38		1.53	1.13	bdl	bdl	bdl	
GC3	4/2/93	20.10	2.00	0.60	0.70	1.21	7.50	1.10	bdl	1.10	31.11		1.22	1.01	bdl	bdl	bdl	
GC3	4/19/93	20.50	2.00	0.80	5.00	1.23	8.80	0.93	0.85	1.20	32.94		1.31	1.06	bdl	bdl	bdl	
GC3	5/3/93	22.40	2.00	0.80	0.50	1.31	7.70	0.83	0.45	0.90	34.16		1.33	1.01	bdl	bdl	bdl	
GC3	5/17/93	23.40	2.30	0.90	0.60	1.41	7.90	1.60	0.95	0.90	39.04		1.52	1.08	bdl	bdl	bdl	
GC3	5/31/93	25.00	2.40	1.00	0.60	1.50	7.20	0.85	0.99	1.10	40.87		1.56	1.04	bdl	bdl	bdl	
GC3	6/14/93	27.30	2.80	0.90	0.70	1.65	6.70	bdl	bdl	0.90	43.31		1.59	0.96	bdl	bdl	bdl	
GC3	7/6/93	31.10	3.60	1.30	0.70	1.92	7.10	0.76	bdl	1.20	51.24		1.87	0.98	bdl	bdl	bdl	
GC3	7/19/93	33.50	3.50	1.60	0.70	2.04	7.50	0.75	bdl	1.30	54.29		1.99	0.97	bdl	bdl	bdl	
GC3	8/9/93	35.00	4.20	1.50	0.70	2.17	6.20	0.95	bdl	1.40	55.51		2.00	0.92	bdl	bdl	bdl	
GC3	8/23/93	35.40	3.90	1.50	0.80	2.17	6.30	0.71	bdl	1.40	55.51		2.01	0.93	0.10	bdl	bdl	
GC3	9/7/93	35.00	3.80	1.60	0.70	2.14	6.50	0.66	bdl	1.40	42.70		1.59	0.74	0.10	bdl	bdl	
GC3	9/21/93	40.40	4.10	1.80	1.10	2.45	7.00	0.71	bdl	1.40	56.12		2.04	0.83	0.10	bdl	bdl	
GC3	11/29/93	14.70	1.70	0.60	0.70	0.92	0.70	0.21	bdl	0.40	18.30		0.63	0.69	bdl	bdl	bdl	
GC3s	12/5/93	21.00	2.00	1.00	0.77	1.29	9.50	1.40	bdl	1.10	25.01		1.07		bdl	bdl	bdl	bdl
GC3	12/13/93	16.70	1.90	0.60	0.90	1.04	8.20	1.00	bdl	1.00	21.35		0.92	0.88	bdl	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
GC3	1/11/93	<0.01	<0.01		bdl	<0.01	<0.01	0.02		<0.01		<0.01	<0.1	<0.01	2.50		4.01		<0.01	0.04	<0.01	<0.01
GC3	1/25/93	<0.01	<0.01			<0.01	0.04	0.01		<0.01		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.06	<0.01	0.07
GC3	2/8/93	<0.01	<0.01			<0.01	<0.01	<0.01		<0.01		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.05	<0.01	<0.01
GC3	2/22/93	<0.01	<0.01			<0.01	<0.01	0.03		<0.01		<0.01	<0.1	bdl	2.50		<0.01		<0.01	0.13	<0.01	0.21
GC3	3/8/93	0.01				0.01		0.01							2.40		bdl			0.03		0.01
GC3	3/22/93	0.02	bdl			bdl	bdl	0.03		bdl		0.01	bdl	bdl	2.70		bdl		bdl	0.03	bdl	0.06
GC3s	3/23/93	0.23	bdl	0.01		0.02	bdl	0.16		bdl		bdl	bdl	bdl	2.70	0.06	bdl	0.04	0.01	0.35	0.08	0.44
GC3	4/2/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	2.40		bdl		bdl	bdl	bdl	bdl
GC3	4/19/93	0.02	bdl			bdl	bdl	0.01		bdl		bdl	bdl	bdl	2.40		bdl		bdl	0.04	bdl	0.03
GC3	5/3/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	2.50		bdl		0.01	0.02	bdl	bdl
GC3	5/17/93	bdl	bdl			bdl	bdl	0.03		bdl		bdl	bdl	bdl	2.60		bdl		0.01	0.03	bdl	0.03
GC3	5/31/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	2.60		bdl		0.03	0.04	bdl	0.09
GC3	6/14/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	2.70		bdl		0.02	0.03	bdl	bdl
GC3	7/6/93	0.05	bdl			bdl	bdl	0.01		bdl		bdl	bdl	bdl	3.10		bdl		0.03	0.01	bdl	0.02
GC3	7/19/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	3.00		bdl		bdl	0.07	bdl	0.01
GC3	8/9/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	3.10		bdl		bdl	0.03	bdl	0.03
GC3	8/23/93	bdl	bdl			bdl	bdl	0.01		bdl		bdl	bdl	bdl	3.10		bdl		bdl	0.03	bdl	0.02
GC3	9/7/93	bdl	bdl			bdl	0.01	0.01		bdl		bdl	bdl	bdl	3.10		bdl		bdl	0.03	bdl	0.04
GC3	9/21/93	bdl	bdl				bdl	bdl		bdl		bdl	bdl	bdl	3.20		bdl		bdl	0.04	bdl	bdl
GC3	11/29/93	0.01	bdl			bdl	bdl	0.02		bdl		bdl	bdl	bdl			bdl		bdl	0.02	bdl	0.02
GC3s	12/5/93	0.13	bdl	0.01	bdl	bdl	bdl	0.09	0.83	bdl	bdl	0.01	bdl	bdl			bdl	bdl	bdl	0.20	0.03	0.22
GC3	12/13/93	0.02	bdl	bdl	bdl	bdl	bdl	0.02	bdl	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.03	bdl	0.03

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
GC4	1/11/93	1435	9.9	7.5	8.5	77	2.60	299	518	72.90	130	149	30	3.40	98.0	<0.1	
GC4	1/25/93	1450	9.9	7.7	7.9	6	1.30	264	440	5.80	150	175	15		120.0	<0.1	
GC4	2/8/93	1320	12.0	8.0	8.5	3	0.17	160	465	5.40	120	131	5		100.0	<0.1	
GC4	2/22/93	1005	9.4	7.9	8.6	13	2.30	237	487	9.30	150	172	15		110.0	<0.1	
GC4	3/8/93	1050	10.7	7.8	7.9	11	1.00	215	485	6.10	140	188	10		130.0		
GC4	3/22/93	1440	11.2	7.6	8.1	8	2.00	226	422	7.40	140	171	15		99.0	bdl	
GC4s	3/23/93	1455	10.3	7.5	8.6	200		129	445	302.00	53	78	35		40.0	bdl	11.00
GC4	4/2/93	1400	8.9	7.6	8.6	5	0.98	352	401	8.80	170	213	5		130.0	bdl	
GC4	4/19/93	1356	13.5	7.9	7.8	4	0.50	132	433	4.60	150	187	10		120.0	bdl	
GC4	5/3/93	1030	12.6	8.0	7.6	3	0.49	132	485	2.40	220	246	10		170.0	bdl	
GC4	5/17/93	1405	16.4	7.8	6.1	5	0.18	293	447	9.80	160	185	10	3.00	140.0	bdl	
GC4	5/31/93	1405	14.5	7.7	8.4	4	0.19	235	335	6.80	140	134	10		120.0	bdl	
GC4	6/14/93	1325	18.2	7.6	6.5	5	0.15	467	388	3.90	200	173	5	bdl	150.0	bdl	
GC4	7/6/93	1100	19.0	6.5	5.8	3	0.05	466	382	1.10	240	219	10		190.0	bdl	
GC4	7/19/93	1540	21.6	7.7	7.0	3	0.10	550	391	2.50	250	291	10		190.0	bdl	
GC4	8/9/93	1132	17.9	7.9	7.6	3	0.09	479	364	5.20	260	268	bdl	bdl	190.0	bdl	
GC4	8/23/93	1410	19.9	7.9	7.3	3	0.20	475	460	2.50	230	255	15		180.0	bdl	
GC4	9/7/93	1544	18.9	7.7	7.8	3		512	441	3.90	260	277	10		190.0	bdl	
GC4	9/21/93	1105	17.5	7.9	7.6	3	0.10	523	427	2.20	270	302	10		150.0	bdl	

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
GC4	1/11/93	38.59	7.80	5.70	2.00	2.86	26.00	1.64	<0.02	7.90	59.78		2.75	0.96	<0.1	<0.1	<0.3	
GC4	1/25/93	44.40	9.50	6.50	2.10		30.00	1.33	<0.02	8.30	73.20			0.99	<0.1	<0.1	<0.3	
GC4	2/8/93	37.89	6.70	2.80	1.20		18.00	0.87	<0.02	4.00	61.00			0.97	<0.1	<0.1	<0.3	
GC4	2/22/93	44.54	9.40	8.50	2.30	3.42	27.00	1.76	<0.02	12.00	67.10		3.13	0.92	<0.1	<0.1	<0.3	
GC4	3/8/93	43.20	8.40	10.00	2.90	3.35	32.00	1.30		12.00	79.30		3.63	1.08				
GC4	3/22/93	39.90	8.70	13.00	2.00	3.32	27.00	1.40	bdl	19.00	60.39		3.11	0.94	bdl	bdl	bdl	
GC4s	3/23/93	17.00	2.40	2.70	2.20	1.26	20.00	2.70	bdl	6.30	24.40		1.44	1.00	bdl	bdl	bdl	
GC4	4/2/93	49.60	11.00	11.00	2.70	3.92	39.00	1.20	bdl	20.00	79.30		4.00	1.02	bdl	bdl	bdl	
GC4	4/19/93	44.30	9.90	7.50	1.80	3.39	35.00	0.39		14.00	73.20		3.61	1.07				
GC4	5/3/93	64.70	14.00	8.40	2.00	4.78	40.00	0.49	bdl	14.00	103.70		4.64	0.97	bdl	bdl	bdl	
GC4	5/17/93	45.90	10.00	4.70	1.40	3.34	31.00	0.44	bdl	7.60	85.40		3.67	1.10	bdl	bdl	8.00	
GC4	5/31/93	43.00	8.80	5.10	1.50	3.12	25.00	0.86	bdl	7.80	73.20		3.15	1.01	bdl	bdl	bdl	
GC4	6/14/93	54.10	15.00	4.70	1.60	4.17	0.10	bdl	bdl	7.10	91.50		3.20	0.77	bdl	bdl	bdl	
GC4	7/6/93	63.50	20.00	7.30	2.20	5.18	bdl	0.25	bdl	12.00	115.90		4.14	0.80	bdl	bdl	bdl	
GC4	7/19/93	69.00	19.00	9.70	2.60	5.48	61.00	0.38	bdl	15.00	115.90		5.50	1.00	bdl	bdl	bdl	
GC4	8/9/93	66.20	22.00	6.90	1.80	5.44	46.00	0.42	bdl	10.00	115.90		5.06	0.93	0.20	bdl	bdl	
GC4	8/23/93	62.80	18.00	7.30	2.20	4.98	45.00	0.33	bdl	11.00	109.80		4.87	0.98	0.30	bdl	bdl	
GC4	9/7/93	68.10	21.00	8.30	2.00	5.52	51.00	0.23	bdl	12.00	115.90		5.22	0.95	0.30	bdl	bdl	
GC4	9/21/93	71.10	22.00	7.40	2.00	5.71	98.00	0.35	bdl	11.00	91.50		5.37	0.94	0.30	bdl	bdl	

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
GC4	1/11/93	0.02	<0.01		bdl	<0.01	<0.01	0.09		0.02		bdl	<0.1	<0.1	2.30		<0.01		<0.01	0.84	0.09	0.23
GC4	1/25/93	<0.01	<0.01			<0.01	0.03	0.04		0.02		<0.01	<0.1	<0.1	2.90		<0.01		<0.01	0.16	0.02	0.11
GC4	2/8/93	<0.01	<0.01			<0.01	<0.01	<0.01		<0.01		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.07	<0.01	<0.01
GC4	2/22/93	<0.01	0.01			<0.01	<0.01	0.10		0.01		<0.01	<0.1	<0.1	2.90		0.02		<0.01	0.14	0.01	0.24
GC4	3/8/93	0.02	0.01					0.04		0.02					2.60					0.23	0.02	0.22
GC4	3/22/93	bdl	bdl			bdl	bdl	0.05		0.01		0.01	bdl	bdl	2.70		bdl		bdl	0.10	0.02	bdl
GC4s	3/23/93	0.29	bdl	0.02		bdl	bdl	0.27		0.02		bdl	bdl	bdl	2.20	0.05	bdl	0.01	0.01	1.20	0.27	0.81
GC4	4/2/93	bdl	bdl			bdl	bdl	0.03		0.02		bdl	bdl	bdl	2.80		bdl		bdl	0.07	0.02	bdl
GC4	4/19/93		0.01					0.02		0.02					2.60					0.09	0.02	
GC4	5/3/93	bdl	bdl			bdl	bdl	bdl		0.02		bdl	bdl	bdl	3.20		bdl		bdl	0.08	0.02	0.02
GC4	5/17/93	bdl	0.01			bdl	bdl	0.02		0.02		bdl	bdl	bdl	3.20		bdl		0.01	0.07	0.02	0.04
GC4	5/31/93	bdl	bdl			bdl	0.01	0.03		0.01		bdl	bdl	bdl	3.00		bdl		0.03	0.12	0.02	0.18
GC4	6/14/93	bdl	bdl			bdl	bdl	0.02		bdl		bdl	bdl	bdl	3.60		bdl		0.02	0.08	0.01	0.02
GC4	7/6/93	0.02	0.01			bdl	bdl	0.02		0.01		bdl	bdl	bdl	4.30		0.01		bdl	0.08	0.02	bdl
GC4	7/19/93	bdl	0.02			bdl	bdl	0.02		0.02		0.01	bdl	bdl	3.70		bdl		bdl	0.08	0.02	0.01
GC4	8/9/93	bdl	0.02			bdl	bdl	0.02		bdl		bdl	bdl	bdl	4.00		bdl		bdl	0.08	0.01	0.03
GC4	8/23/93	0.01	0.02			bdl	bdl	0.02		bdl		bdl	bdl	bdl	3.80		bdl		0.01	0.07	bdl	0.03
GC4	9/7/93	bdl	0.03			bdl	0.01	0.02		bdl		bdl	bdl	bdl	4.00		bdl		bdl	0.06	bdl	0.10
GC4	9/21/93	bdl	0.02			bdl	bdl	0.02		bdl		bdl	bdl	bdl	3.90		bdl		0.01	0.05	bdl	bdl

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Site	Date		Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
GC7	1/11/93	1450	11.0	7.6	8.4	53	10.20	190	515	43.80	95	106	35	1.50	73.0	<0.1	
GC7	1/25/93	1510	10.6	7.8	8.6	7	15.50	180	447	6.20	83	93	15		63.0	<0.1	
GC7	2/8/93	1330	11.6	8.1	9.8	4	3.20	99	475	4.80	86	97	5		74.0	<0.1	
GC7	2/22/93	1030	10.7	8.0	8.4	16	29.70	154	481	24.90	82	90	20		64.0	<0.1	
GC7	3/8/93	1110	11.2	7.7	8.8	12	13.50	170	464	6.50	77	98	10		72.0		
GC7	3/22/93	1500	11.8	7.7	8.4	9	25.00	155	408	11.10	71	85	15		55.0	bdl	
GC7s	3/23/93	1505	10.2	7.5	8.6	200		147	452	381.00	62	89	40		50.0	bdl	11.00
GC7	4/2/93	1415	10.0	7.5	8.2	5	8.30	177	408	10.70	78	93	5		65.0	bdl	
GC7	4/19/93	1409	15.5	7.9	8.3	4	6.10	153	435	3.70	80	99	5		72.0		
GC7	5/3/93	1005	12.9	7.9	8.5	5	5.30	18	504	3.60	81	88	10		67.0	bdl	
GC7	5/17/93	1420	16.2	8.0	7.5	6	1.60	175	405	6.00	95	113	10		85.0	bdl	
GC7	5/31/93	1415	15.0	7.8	8.6	3	1.40	236	359	4.40	100	79	10		23.0	bdl	
GC7	7/6/93	1110	17.4	6.5	6.5	5	0.76	263	403	3.50	130	142	10	bdl	110.0	bdl	
GC7	7/19/93	1545	21.4	7.9	7.1	7	0.60	382	383	6.30	170	209	10		130.0	bdl	
GC7	8/9/93	1045	17.3	7.9	7.9	5	0.84	314	373	7.10	150	174	10	bdl	130.0	bdl	
GC7	8/23/93	1350	19.4	8.0	8.0	4	0.65	296	476	5.50	150	175	10		130.0	bdl	
GC7	9/7/93	1554	19.6	7.7	75.0	5		325	445	7.50	160	175	10		120.0	bdl	
GC7	9/21/93	1118	17.6	7.9	7.7	6	0.45	361	434	11.80	220	208	15		120.0	bdl	
GC7	10/7/93	0932	13.8	7.8	7.4	5	0.55	362	502	2.50	160	189	10		120.0	bdl	
GC7	10/18/93	1030	15.0	7.7	7.0	6	0.52	403	527	4.60	200	223	15		140.0	bdl	
GC7	11/4/93	1451	10.3	7.8	9.2	3		405	485	3.20	200	221	10		130.0	bdl	
GC7	11/15/93	0950	13.7	7.6	7.2	bdl	2.20	453	467	16.30	210	255	20		130.0	bdl	
GC7	11/29/93	1013	9.8	7.8	10.0	bdl		176	486	6.30	80	89	10		51.0	bdl	
GC7s	12/5/93	1059	11.8	7.7	9.2	bdl		168	481	50.10	81	87	25		53.0	bdl	1.50
GC7	12/13/93	1222	11.2	7.7	9.2	bdl	4.70	175	410	5.00	82	90	10		57.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
GC7	1/11/93	30.15	4.80	2.70	1.50	2.05	17.00	2.43	<0.02	3.30	44.53		1.95	0.95	<0.1	<0.1	<0.3	
GC7	1/25/93	26.55	4.10	1.90	1.20		15.00	3.09	<0.02	2.70	38.43			0.97	<0.1	<0.1	<0.3	
GC7	2/8/93	27.92	4.00	2.50	1.20		12.00	2.12	<0.02	2.70	45.14			0.99	<0.1	<0.1	<0.3	
GC7	2/22/93	27.05	3.40	1.80	1.20	1.74	13.00	2.28	<0.02	2.90	39.04		1.67	0.96	<0.1	<0.1	<0.3	
GC7	3/8/93	25.10	3.60	2.80	1.00	1.70	15.00	2.20		4.50	43.92		1.93	1.14	0.30			
GC7	3/22/93	23.50	3.10	2.40	0.80	1.55	15.00	2.00	bdl	5.10	33.50		1.59	1.02	bdl	bdl	bdl	
GC7s	3/23/93	20.00	2.90	2.50	2.70	1.45	27.00	3.40	bdl	bdl	30.50		1.63	1.12	0.20	bdl	bdl	
GC7	4/2/93	25.10	3.60	2.70	1.20	1.69	15.00	1.80	0.65	4.00	39.65		1.77	1.05	bdl	bdl	bdl	
GC7	4/19/93	25.80	3.80	2.40	0.90	1.72	16.00	1.90	1.00	3.60	43.92		1.93	1.12				
GC7	5/3/93	27.00	3.30	2.00	0.90	1.72	11.00	1.20	bdl	2.30	40.87		1.65	0.96	bdl	bdl	bdl	
GC7	5/17/93	30.80	4.40	3.10	1.00	2.06	15.00	3.70	0.46	3.90	51.85		2.19	1.07	bdl	bdl	bdl	
GC7	5/31/93	32.10	4.90	3.70	1.20	2.19	16.00	2.00	0.64	4.60	14.03		0.97	0.44	bdl	bdl	bdl	
GC7	7/6/93	39.00	7.40	4.10	1.50	2.76	19.00	1.60	bdl	3.30	67.10		2.72	0.98	bdl	bdl	bdl	
GC7	7/19/93	52.70	9.90	8.40	2.90	3.87	44.00	4.40	bdl	8.50	79.30		3.83	0.99	bdl	bdl	bdl	
GC7	8/9/93	46.60	8.50	6.40	1.90	3.35	23.00	3.50	bdl	5.90	79.30		3.31	0.99	0.20	bdl	bdl	
GC7	8/23/93	46.30	7.90	7.10	2.10	3.32	24.00	1.80	bdl	7.20	79.30		3.34	1.01	0.20	bdl	bdl	
GC7	9/7/93	48.80	8.80	7.60	2.00	3.53	27.00	1.70	bdl	6.60	73.20		3.19	0.90	0.20	bdl	bdl	
GC7	9/21/93	57.80	6.60	2.90	1.00	4.13	16.00	0.24	bdl	8.50	103.70		3.40	0.85	0.30	bdl	bdl	
GC7	10/7/93	49.80	9.40	9.90	2.60	3.45	29.00	6.00	bdl	9.60	73.20		3.39	0.90	0.30	bdl	bdl	
GC7	10/18/93	59.00	12.00	9.20	3.30	4.41	44.00	1.80	bdl	9.40	85.40		4.03	0.91	0.30	bdl	bdl	
GC7	11/4/93	58.60	12.00	8.10	2.70	4.32	47.00	4.30	bdl	10.00	79.30		3.95	0.91	0.30	bdl	bdl	
GC7	11/15/93	63.00	13.00	10.00	5.00	4.78	68.00	4.70	bdl	13.00	79.30		4.47	0.94	0.30	bdl	bdl	
GC7	11/29/93	25.30	4.10	2.40	1.50	1.74	20.00	1.90	bdl	2.90	31.11		1.55	0.89	0.10	bdl		
GC7s	12/5/93	27.00	3.50	1.40	1.10	1.74	18.00	1.60	bdl	2.00	32.33		1.52	bdl	0.10	bdl	bdl	
GC7	12/13/93	26.20	4.00	2.40	1.00	1.76	18.00	1.20	bdl	2.90	34.77		1.63	0.92	0.20	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
GC7	1/11/93	<0.01	<0.01			<0.01	<0.01	0.05		0.01	bdl	<0.01	0.10	<0.1	2.70		<0.01		<0.01	0.58	0.04	0.16
GC7	1/25/93	<0.01	<0.01			<0.01	<0.01	0.03		<0.01		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.12	0.01	0.12
GC7	2/8/93	<0.01	<0.01			<0.01	<0.01	<0.01		<0.01		<0.01	<0.1	<0.1	2.70		<0.01		<0.01	0.06	<0.01	<0.01
GC7	2/22/93	<0.01	<0.01			<0.01	<0.01	0.05		<0.01		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.24	0.01	0.34
GC7	3/8/93	0.04						0.02		0.07					2.50		8.00			0.14	0.01	0.13
GC7	3/22/93	0.02	bdl			bdl	bdl	0.03		bdl		0.01	bdl	bdl	2.80		bdl		bdl	0.09	0.01	0.07
GC7s	3/23/93	0.28	bdl	0.02		bdl	bdl	0.17		0.02		bdl	bdl	bdl	2.40	0.07	0.01	0.01	0.02	1.50	0.27	1.10
GC7	4/2/93	bdl	bdl			bdl	bdl	0.02		bdl		bdl	bdl	bdl	2.50		bdl		bdl	0.04	bdl	0.04
GC7	4/19/93							0.02							2.50					0.11	0.01	0.07
GC7	5/3/93	bdl	0.01			bdl	bdl	0.01		bdl		bdl	bdl	bdl	2.60		bdl		0.02	0.07	bdl	0.04
GC7	5/17/93	0.01	0.01			bdl	bdl	0.03		bdl		bdl	bdl	bdl	2.80		bdl		0.01	0.07	0.01	0.09
GC7	5/31/93	0.02	bdl			bdl	bdl	0.03		bdl		bdl	bdl	bdl	2.80		bdl		0.04	0.13	0.01	0.15
GC7	7/6/93	bdl	bdl			bdl	bdl	0.02		bdl		bdl	0.10	bdl	3.50		bdl		bdl	0.10	0.01	0.12
GC7	7/19/93	bdl	0.02			bdl	bdl	0.03		0.01		bdl	0.20	bdl	3.60		bdl		bdl	0.02	0.02	0.07
GC7	8/9/93	0.03	0.03			bdl	bdl	0.02		bdl		bdl	0.20	bdl	3.50		bdl		bdl	0.15	0.02	0.10
GC7	8/23/93	bdl	0.02			bdl	bdl	0.03		0.01		bdl	0.20	bdl	3.60		bdl		0.02	0.12	0.02	0.10
GC7	9/7/93	bdl	0.03			bdl	0.01	0.03		0.01		bdl	0.20	bdl	3.60		bdl		bdl	0.12	0.02	0.08
GC7	9/21/93	0.01	0.03				0.02	0.07		0.06		bdl	bdl	bdl	3.50		bdl		bdl	0.32	0.07	0.03
GC7	10/7/93	bdl	0.01			bdl	bdl	0.02		bdl		bdl	0.30	bdl	3.70		bdl		0.02	0.16	0.01	0.04
GC7	10/18/93	0.01	0.03			bdl	bdl	0.05		0.01		bdl	0.20	bdl	3.70		bdl		0.02	0.19	0.02	0.12
GC7	11/4/93	bdl	0.03			bdl	bdl	0.04		bdl		bdl	bdl	bdl	3.50		bdl		0.05	0.12	0.01	0.03
GC7	11/15/93	0.09	0.03			bdl	bdl	0.11		0.03		bdl	0.10	bdl	3.00		bdl		0.04	0.32	0.05	0.41
GC7	11/29/93	0.02	bdl			bdl	bdl	0.03		0.01		bdl	bdl	bdl			bdl		0.04	0.08	0.02	0.09
GC7s	12/5/93	0.16	0.01	0.02	bdl	bdl	bdl	0.10	0.88	bdl	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.25	0.04	0.23
GC7	12/13/93	0.01	bdl	bdl	bdl	bdl	bdl	0.03	bdl	0.01	bdl	bdl	bdl	bdl			bdl		0.01	0.07	0.01	0.12

Station LH5 Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
LH5	1/11/93	1400	8.9	7.2	9.3	11	0.88	104	540	7.50	49	52	10		38.0	<0.1	
LH5s	3/23/93	1535	8.1	6.7	8.7	200		50	508	344.00	15	24	30		8.6	bdl	11.00
LH5s	12/5/93	1306	9.9	7.0	9.7	bdl	7.10	62	517	13.10	26	28	15		16.0	bdl	3.00

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
LH5	1/11/93	15.73	2.40	0.70	0.90	1.03	8.40	<0.05	<0.02	1.00	23.18		0.96	0.93	<0.1	<0.1	7.50	
LH5s	3/23/93	4.20	0.99	0.32	0.83	0.36	11.00	0.50	bdl	0.80	5.25		0.43	1.20	bdl	bdl	bdl	
LH5s	12/5/93	8.00	1.40	0.39	0.74	0.57	7.00	0.16	bdl	0.60	9.76		0.49		bdl	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LH5	1/11/93	<0.01	<0.01			<0.01	<0.01	0.04		<0.01		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.15	<0.01	0.07
LH5s	3/23/93	0.23	bdl	0.01		bdl	bdl	0.26		0.01		bdl	bdl	bdl	2.00	0.01	bdl	bdl	0.02	0.74	0.27	1.10
LH5s	12/5/93	0.16	bdl	0.02	bdl	bdl	bdl	0.09	0.85	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.17	0.01	0.63

Station MF2 Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
MF2	1/29/93	1420	5.7	4.9	10.1	1	0.96	18	672	8.70	4	8	5		0.2	6.8	
MF2	4/17/93	1515	7.3	4.1	8.3	bdl		16	636	8.00	4	7	10	bdl	bdl	bdl	
MF2	10/15/93	1339	11.4	5.0	7.9	bdl	0.22	17	589	5.40	4	7	10		0.3	2.7	

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
MF2	1/29/93	0.81	0.43	0.20	0.30		3.60	2.16	<0.02	0.60	0.12			1.41	<0.1	<0.1	<0.3	
MF2	4/17/93	0.95	0.43	0.60	0.30	0.12	3.70	1.00	bdl	0.20			0.10	0.81	bdl	bdl	bdl	
MF2	10/15/93	0.88	0.44	0.30	0.40	0.11	3.60	0.16	bdl	0.80	0.18		1.06	0.97	bdl	bdl	bdl	

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
MF2	1/29/93	<0.01	<0.01			<0.01	<0.01	<0.01		0.02		<0.01	<0.1	<0.1	1.40		<0.01		<0.01	0.04	0.02	0.06
MF2	4/17/93	0.04	bdl			bdl	bdl	bdl		0.02		bdl	bdl	bdl	1.30		bdl		0.02	0.05	0.02	0.08
MF2	10/15/93	0.03	0.01			bdl	bdl	0.02		0.05		bdl	bdl	bdl	1.60		bdl		0.03	0.03	0.06	0.08

Station MF5 Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
MF5	1/29/93	1500	5.3	4.7	9.8	2	4.10	18	651	3.20	3	7	10		<0.1	7.5	
MF5	4/15/93	1445	11.4	4.6	7.6	bdl	4.20	19	662	1.60	4	7	5		bdl	bdl	
MF5	10/15/93	1429	11.0	4.5	7.7	bdl	0.55	23	616	3.50	4	8	20		bdl	3.7	

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
MF5	1/29/93	0.43	0.41	0.20	0.30		4.10	0.82	<0.02	0.60				1.40	<0.1	<0.1	<0.3	
MF5	4/15/93	0.78	0.30	0.30	0.98	0.10	4.30	0.37	bdl	0.20			0.10		bdl	bdl	bdl	
MF5	10/15/93	0.90	0.44	0.20	0.30	0.12	4.60	bdl	bdl	0.80			0.12	0.97	bdl	bdl	bdl	

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
MF5	1/29/93	0.08	<0.01			<0.01	<0.01	0.01		0.02		<0.01	<0.1	<0.1	1.50		<0.01		<0.01	0.04	0.02	0.10
MF5	4/15/93	0.09	bdl			bdl	bdl	0.03		0.39		bdl	bdl	bdl	1.30		bdl		0.02	0.07	0.02	0.09
MF5	10/15/93	0.17	bdl			bdl	bdl	0.06		0.10		bdl	bdl	bdl	1.80		bdl		0.03	0.09	0.10	0.18

Station RR1 Water Quality Data 1993 Page 1 of 3

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
RR1	1/11/93	1030	9.0	6.8	9.0	15	0.23	187	515	12.00	70	103	5	0.60	43.0	<0.1	
RR1	1/25/93	1250	6.4	7.8	10.2	15	0.42	163	436	12.50	62	93	10		34.0	<0.1	
RR1	2/8/93	1030	5.2	7.2	10.4	13	0.16	186	418	14.00	65	102	10		32.0	<0.1	
RR1	2/22/93	1250	6.9	7.5	9.7	6	0.95	135	474	9.30	56	81	5		36.0	<0.1	
RR1	3/8/93	1405	7.9	7.2	9.2	7	0.41	196	457	6.80	65	114	10		41.0		
RR1	3/22/93	1305	8.8	7.0	9.6	7	1.00	196	496	6.60	54	98	10		29.0	bdl	
RR1s	3/23/93	1335	8.6	7.7	7.3	200	11.50	105	451	715.00	38	70	40		34.0	bdl	13.00
RR1	4/2/93	1030	7.4	7.1	9.4	11	0.60	207	379	6.40	64	174	5		130.0	bdl	
RR1	4/19/93	1030	11.7	7.5	8.2	17	0.70	179	423	19.20	67	118	15		41.0	bdl	
RR1	5/3/93	1320	12.3	7.4	7.8	34	0.20	172	392	27.10	67	108	35		36.0	bdl	
RR1	5/17/93	1040	13.9	7.3	6.8	4	0.23	175	415	11.50	64	113	10		34.0	bdl	
RR1	5/31/93	1015	13.5	7.2	1.5	4	0.18	221	417	3.40	60	99	10		27.0		
RR1	6/14/93	1030	15.4	6.8	7.1	6	0.19	213	308	12.40	64	103	bdl	bdl	30.0	bdl	
RR1	7/6/93	1425	19.7	8.0	5.8	5	0.34	203	424	4.20	56	111	5	0.03	34.0	bdl	
RR1	7/19/93	1025	17.7	7.7	7.1	9	0.10	219	273	9.50	72	114	5		34.0	bdl	
RR1	8/9/93	1409	18.2	7.7	7.9	19	0.09	197	385	13.50	69	102	10	bdl	35.0	bdl	
RR1	8/23/93	1140	19.5	7.8	8.0	12	0.54	240	440	15.50	70	102	15	bdl	36.0	bdl	
RR1	9/7/93	1411	18.2	6.9	7.0	4		272	529	5.50	68	101	10		33.0	bdl	
RR1	9/21/93	0948	16.0	7.7	6.6	5	0.10	208	414	5.40	75	107	10		34.0	bdl	
RR1	10/7/93	1124	13.2	7.3	8.4	5	0.09	205	411	5.70	71	101	10		33.0	bdl	
RR1	10/18/93	1201	14.4	7.2	4.0	51	0.21	205	470	38.20	73	104	10		30.0	bdl	
RR1	11/4/93	1141	9.7	7.2	8.2	57		214	382	51.00	72	109	25		37.0	bdl	
RR1	11/15/93	1302	12.8	7.2	7.4	bdl	0.14	229	413	9.30	82	129	bdl		43.0	bdl	
RR1	11/29/93	1509	7.2	7.3	2.9	bdl		234	341	11.90	82	125	10		37.0	bdl	
RR1s	12/5/93	0925	9.9	7.5	9.8	bdl	2.20	153	482	8.00	56	73	15	bdl	35.0	bdl	2.40
RR1	12/13/93	1151	7.2	7.3	10.4	bdl	0.19	219	402	20.80	80	119	10	bdl	44.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
RR1	1/11/93	20.67	4.40	8.80	1.20	1.82	27.00	0.50	<0.02	14.00	26.23		1.82	1.00	<0.1	<0.1	<0.3	
RR1	1/25/93	19.21	3.50	7.00	1.10		24.00	7.53	<0.02	9.80	20.74			1.00	<0.1	<0.1	<0.3	
RR1	2/8/93	17.69	5.00	8.90	1.50		32.00	1.14	<0.02	16.00	19.52			1.03	<0.1	<0.1	<0.3	
RR1	2/22/93	18.30	2.60	7.80	1.00	1.49	17.00	0.65	<0.02	12.00	21.96		1.42	0.95	<0.1	<0.1	<0.3	
RR1	3/8/93	20.30	3.50	17.00	1.30	2.08	26.00	0.92		20.00	25.01		1.94	0.93				
RR1	3/22/93	17.70	2.50	16.00	0.90	1.81	17.00	1.90	bdl	24.00	41.48		1.65	0.91	bdl	bdl	bdl	
RR1s	3/23/93	13.00	1.50	4.10	1.50	1.11	18.00	1.70	bdl	8.80	70.74		1.33	1.20	bdl	bdl	bdl	
RR1	4/2/93	20.10	3.40	14.00	1.30	1.93	32.00	0.54	bdl	24.00	79.30		3.95	2.05	bdl	bdl	bdl	
RR1	4/19/93	19.80	4.20	12.00	1.10	1.89	34.00	1.20	1.00	20.00	25.01		2.13	1.13	bdl	bdl	bdl	
RR1	5/3/93	19.20	4.60	11.00	1.20	1.86	31.00	0.48	bdl	19.00	21.96		1.91	1.00	bdl	bdl	bdl	
RR1	5/17/93	16.90	5.20	11.00	1.40	1.80	35.00	0.88	bdl	22.00	20.74		2.04	1.14	bdl	bdl	bdl	
RR1	5/31/93	16.30	4.80	10.00	1.70	1.71	29.00	0.92	bdl	20.00	16.47		1.72	1.01			bdl	
RR1	6/14/93	17.00	5.00	9.90	1.60	1.76	26.00	3.40	bdl	21.00	18.30		1.79	1.02	bdl	bdl	bdl	
RR1	7/6/93	18.40	5.40	10.00	1.80	1.86	34.00	1.50	bdl	19.00	20.74		1.95	1.05	bdl	bdl	bdl	
RR1	7/19/93	19.40	5.70	9.80	2.00	1.93	35.00	1.60	bdl	20.00	20.74		2.00	1.03	bdl	0.4	bdl	
RR1	8/9/93	18.60	5.50	9.60	1.90	1.86	27.00	1.00	bdl	17.00	21.35		1.77	0.95	0.20	bdl	bdl	
RR1	8/23/93	19.50	5.30	9.70	2.10	1.90	25.00	0.96	bdl	17.00	21.96		1.75	0.92	0.20	bdl	bdl	
RR1	9/7/93	18.40	5.40	9.30	1.70	1.82	29.00	0.96	bdl	16.00	20.13		1.74	0.96	0.20	bdl	bdl	
RR1	9/21/93	20.50	5.80	9.20	1.90	1.96	30.00	0.81	bdl	18.00	20.74		1.84	0.94	0.20	bdl	bdl	
RR1	10/7/93	18.90	5.70	9.00	1.80	1.87	27.00	0.86	bdl	17.00	20.13		1.73	0.92	0.20	bdl	bdl	
RR1	10/18/93	20.00	5.60	9.70	1.70	1.95	28.00	0.67	bdl	20.00	18.30		1.77	0.91	0.20	bdl	bdl	
RR1	11/4/93	19.20	5.90	9.20	1.80	1.91	29.00	0.98	bdl	20.00	22.57		1.93	1.01	0.20	bdl	bdl	
RR1	11/15/93	20.70	7.30	9.60	1.90	2.14	42.00	0.87	bdl	20.00	26.23		2.33	1.09	0.30	bdl	bdl	
RR1	11/29/93	21.90	6.60	11.00	1.70	2.17	38.00	2.40	bdl	21.00	22.57		2.17	1.00	0.20	bdl	bdl	
RR1s	12/5/93	19.00	2.20	4.90	0.93	1.38	17.00	0.67	bdl	6.90	21.35		1.27		0.20	bdl	bdl	bdl
RR1	12/13/93	23.90	4.90	10.00	1.20	2.08	33.00	0.65	bdl	18.00	26.84		2.09	1.01	0.10	bdl	bdl	bdl

Station RR1 Water Quality Data 1993 Page 3 of 3

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
RR1	1/11/93	0.09	<0.01			<0.01	<0.01	0.09		0.19		<0.01	<0.1	<0.1	2.80		<0.01		0.02	0.38	0.28	0.70
RR1	1/25/93	0.06	<0.01			<0.01	<0.01	0.08		0.15		<0.01	<0.1	<0.1	2.60		<0.01		0.04	0.36	0.18	0.53
RR1	2/8/93	<0.01	0.02			<0.01	<0.01	0.13		0.28		<0.01	<0.1	<0.1	3.00		<0.01		0.02	0.70	0.30	1.40
RR1	2/22/93	0.02	<0.01			<0.01	<0.01	0.03		0.05		<0.01	<0.1	<0.1	2.20		<0.01		<0.01	0.10	0.05	0.23
RR1	3/8/93	0.04						0.06		0.15		0.01			2.50				0.01	0.22	0.16	0.33
RR1	3/22/93	0.02	bdl			bdl	bdl	0.02		0.04		0.01	bdl	bdl	2.40		bdl		0.01	0.07	0.05	0.06
RR1s	3/23/93	0.93	0.01	0.03		bdl	bdl	0.38		0.05		0.07	bdl	bdl	1.80	bdl	0.05	0.01	0.02	2.60	0.72	2.20
RR1	4/2/93	bdl	bdl			bdl	bdl	0.03		0.13		bdl	bdl	bdl	2.30		bdl		0.03	0.08	1.40	0.25
RR1	4/19/93	0.01	bdl			bdl	bdl	0.03		0.16		bdl	bdl	bdl	2.50		bdl		0.01	0.56	0.23	0.57
RR1	5/3/93	0.06	bdl			bdl	bdl	0.09		0.21		bdl	bdl	bdl	3.00		bdl		0.02	1.00	0.25	0.97
RR1	5/17/93	0.03	bdl			bdl	bdl	0.13		0.28		bdl	bdl	bdl	3.30		bdl		0.02	0.28	0.28	0.67
RR1	5/31/93	0.08					0.01	0.14		0.26		bdl	bdl	bdl	3.40		bdl		0.05	0.27	0.27	0.58
RR1	6/14/93	0.07	bdl			bdl	bdl	0.12		0.22		bdl	bdl	bdl	3.70		bdl		0.03	0.51	0.23	0.57
RR1	7/6/93	0.08	bdl			bdl	bdl	0.05		0.21		bdl	bdl	bdl	3.90		bdl		bdl	0.29	0.21	0.25
RR1	7/19/93	0.08	bdl			bdl	bdl	0.11		0.29		0.01	bdl	bdl	3.80		bdl		bdl	0.54	0.35	0.63
RR1	8/9/93	0.07	bdl			bdl	bdl	0.01		0.23		bdl	bdl	bdl	3.70		bdl		bdl	0.65	0.26	0.50
RR1	8/23/93	0.07	bdl			bdl	bdl	bdl		0.20		bdl	bdl	bdl	3.80		bdl		bdl	0.76	0.22	0.47
RR1	9/7/93	0.07	bdl			bdl	bdl	0.03		0.23		bdl	bdl	bdl	3.70		bdl		0.01	0.34	0.24	0.25
RR1	9/21/93	0.06	bdl			bdl	bdl	0.09		0.23		bdl	bdl	bdl	3.70		bdl		0.02	0.43	0.25	0.31
RR1	10/7/93	0.04	bdl			bdl	bdl	0.25		0.25		bdl	bdl	bdl	3.70		bdl		0.02	0.58	0.28	0.54
RR1	10/18/93	0.08	bdl			bdl	bdl	0.14		0.32		bdl	bdl	bdl	3.70		bdl		0.02	2.20	0.36	0.53
RR1	11/4/93	0.04	0.01			bdl	bdl	0.31		0.30		bdl	bdl	bdl	3.60		bdl		0.03	3.10	0.32	1.10
RR1	11/15/93	0.11	bdl			bdl	bdl	0.34		0.45		0.02	bdl	bdl	3.80		bdl		0.04	0.55	0.47	0.61
RR1	11/29/93	0.03	bdl			bdl	bdl	0.29		bdl		0.03	bdl	bdl			bdl		0.01	0.60	0.37	0.63
RR1s	12/5/93	0.13	bdl	0.02	bdl	bdl	bdl	0.07	0.92	0.03	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.09	0.03	0.15
RR1	12/13/93	0.07	bdl	bdl	bdl	bdl	bdl	0.10	bdl	0.22	bdl	bdl	bdl	bdl			bdl	bdl	0.02	0.74	0.26	0.65

Station SH10 Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
SH10	1/29/93	1330	4.3	5.5	10.2	6	3.60	19	614	4.40	5	12	5		<0.1	6.9	
SH10	4/15/93	1335	11.0	4.3	10.5	bdl	4.00	17	666	3.50	4	8	10		bdl	bdl	
SH10	10/15/93	1246	10.5	5.8	8.9	bdl	0.96	22	562	bdl	5	5	10		2.0	2.5	

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
SH10	1/29/93	1.24	0.54	0.30	0.40		6.30	2.23	<0.02	0.80				1.37	<0.1	<0.1	<0.3	
SH10	4/15/93	0.92	0.48	0.30	0.30	0.12	5.00	bdl	bdl	0.50			0.12	1.01	bdl	bdl	bdl	
SH10	10/15/93	0.90	0.60	0.04	1.41	0.12	1.70	bdl	bdl	0.80	1.22		0.18	8.00	bdl	bdl	bdl	

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
SH10	1/29/93	0.07	<0.01			<0.01	<0.01	0.01		0.03		<0.01	<0.1	<0.1	1.50		<0.01		0.02	0.04	0.03	0.08
SH10	4/15/93	0.09	bdl			bdl	bdl	bdl		0.03		bdl	bdl	bdl	1.40		bdl		0.02	0.02	0.03	0.09
SH10	10/15/93	0.04	bdl			bdl	bdl	bdl		0.61		0.20	bdl	bdl	bdl		9.78		4.50	bdl	0.03	0.04

Station ST5 Water Quality Data 1993

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
ST5	1/11/93	1340	8.7	7.2	7.7	6	2.60	92	537	3.50	38	43	40		29.0	<0.1	
ST5s	12/5/93	1255	9.7	7.0	9.8	bdl	11.60	49	512	13.40	19	26	20		15.0	bdl	3.30

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
ST5	1/11/93	11.18	2.50	0.80	1.00	0.83	8.50	<0.05	<0.02	0.90	17.69		0.78	0.95	<0.1	<0.1	<0.3	
ST5s	12/5/93	5.50	1.30	0.48	0.96	0.44	7.70	0.20	bdl	0.80	9.15		0.49		bdl	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ST5	1/11/93	0.03	<0.01			<0.01	<0.01	0.03		<0.01		<0.01	<0.1	<0.1	3.20		<0.01		<0.01	0.09	<0.01	0.08
ST5s	12/5/93	0.11	bdl	0.02	bdl	bdl	bdl	0.08	1.10	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.22	0.02	0.26

Station ST10 Water Quality Data 1993

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
ST10	1/11/93	1320	9.2	7.2	9.0	3	2.30	142	536	2.60	73	76	10		60.0	<0.1	
ST10	3/23/93	1530	8.7	7.3	7.4	200		51	473	335.00	20	29	30		12.0	bdl	12.00
ST10s	12/5/93	1246	10.2	7.2	9.6	bdl	20.60	105	510	16.50	50	43	25		20.0	bdl	3.40

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
ST10	1/11/93	24.61	2.90	1.20	0.80	1.54	8.60	0.49	<0.02	1.30	36.60		1.42	0.93	<0.1	<0.1	<0.3	
ST10	3/23/93	6.50	0.99	0.32	0.88	0.47	11.00	0.38	bdl	0.90	7.32		0.50	1.07	bdl	bdl	bdl	
ST10s	12/5/93	17.00	1.70	0.66	1.00	1.07	8.50	0.50	bdl	1.10	12.20		0.62		0.10	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ST10	1/11/93	<0.01	<0.01			<0.01	<0.01	0.03		<0.01		<0.01	<0.1	<0.1	3.20		<0.01		<0.01	0.09	<0.01	0.04
ST10	3/23/93	0.18	bdl	0.02		bdl	bdl	0.19		0.03		bdl	bdl	bdl	1.90	0.01	0.01	bdl	0.02	1.30	0.40	1.20
ST10s	12/5/93	0.22	bdl	0.20	bdl	bdl	bdl	0.15	0.58	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.21	0.03	0.28

Station ST10 Water Quality Data 1993

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
ST10	1/11/93	1320	9.2	7.2	9.0	3	2.30	142	536	2.60	73	76	10		60.0	<0.1	
ST10	3/23/93	1530	8.7	7.3	7.4	200		51	473	335.00	20	29	30		12.0	bdl	12.00
ST10s	12/5/93	1246	10.2	7.2	9.6	bdl	20.60	105	510	16.50	50	43	25		20.0	bdl	3.40

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
ST10	1/11/93	24.61	2.90	1.20	0.80	1.54	8.60	0.49	<0.02	1.30	36.60		1.42	0.93	<0.1	<0.1	<0.3	
ST10	3/23/93	6.50	0.99	0.32	0.88	0.47	11.00	0.38	bdl	0.90	7.32		0.50	1.07	bdl	bdl	bdl	
ST10s	12/5/93	17.00	1.70	0.66	1.00	1.07	8.50	0.50	bdl	1.10	12.20		0.62		0.10	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ST10	1/11/93	<0.01	<0.01			<0.01	<0.01	0.03		<0.01		<0.01	<0.1	<0.1	3.20		<0.01		<0.01	0.09	<0.01	0.04
ST10	3/23/93	0.18	bdl	0.02		bdl	bdl	0.19		0.03		bdl	bdl	bdl	1.90	0.01	0.01	bdl	0.02	1.30	0.40	1.20
ST10s	12/5/93	0.22	bdl	0.20	bdl	bdl	bdl	0.15	0.58	bdl	bdl	bdl	bdl	bdl			bdl	bdl	bdl	0.21	0.03	0.28

Station STOR1 Water Quality Data 1993

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
STOR1	1/11/93	1515	9.5	7.4	8.0	200	0.80	220	524	195.00	96	122	10		87.0	<0.1	
STOR1	2/22/93	1110	9.7	7.4	7.6	12	0.46	150	495	4.70	82	90	10		64.0	<0.1	
STOR1	3/22/93	1515	9.8	6.8	7.7	6	0.49	200	463	7.30	88	107	15		76.0	bdl	
STOR1s	3/23/93	1520	9.0	7.3	8.4	200	5.50	113	463	195.00	45	69	35		35.0	bdl	12.00
STOR1s	12/5/93	1114	12.0	7.4	7.9	bdl	0.20	268	478	5.90	130	139	15		86.0	bdl	5.40

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
STOR1	1/11/93	31.46	4.40	3.40	3.80	2.25	16.00	3.32	<0.02	6.10	53.07		2.31	1.03	0.30	<0.1	<0.3	
STOR1	2/22/93	26.99	3.50	1.60	2.10	1.76	13.00	1.67	<0.02	2.30	39.04		1.64	0.94	<0.1	<0.1	<0.3	
STOR1	3/22/93	30.50	3.00	4.30	1.60	1.99	12.00	1.60	bdl	7.90	46.36		2.02	1.01	bdl	bdl	bdl	
STOR1s	3/23/93	14.00	2.20	2.20	2.20	1.06	17.00	4.60	bdl	1.40	21.35		1.25	1.18	0.20	bdl	bdl	
STOR1s	12/5/93	41.00	6.10	2.50	2.80	2.73	30.00	3.00	bdl	2.00	52.46		2.45		bdl	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr.	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
STOR1	1/11/93	0.61	0.01			<0.01	<0.01	0.41		0.02		<0.01	0.10	<0.1	2.60		0.01		0.02	0.13	0.09	0.78
STOR1	2/22/93	<0.01	<0.01			<0.01	<0.01	0.07		0.01		<0.01	<0.1	<0.1	2.30		<0.01		0.01	0.16	0.01	0.22
STOR1	3/22/93	bdl	bdl			bdl	bdl	0.04		0.02		bdl	bdl	bdl	2.50		bdl		0.01	0.08	0.02	bdl
STOR1s	3/23/93	0.21	0.01	bdl		bdl	bdl	0.16		0.03		0.02	bdl	bdl	1.50	0.08	bdl	bdl	0.02	0.83	0.09	0.64
STOR1s	12/5/93	0.08	0.02	0.02	bdl	bdl	bdl	0.08	0.90	0.01	bdl	bdl	bdl	bdl			bdl	0.01	0.02	0.18	0.01	0.25

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
TC10	1/11/93	0940	11.1	7.3	9.2	5	2.50	130	567	4.20	67	79	<5	0.80	59.0	<0.1	
TC10	1/25/93	1145	8.9	8.9	9.9	67	4.10	258	475	42.50	120	160	15	3.30	47.0	<0.1	
TC10	2/8/93	0825	7.1	7.1	10.3	15	1.80	222	382	14.90	120	193	5	0.45	23.0	<0.1	
TC10	2/22/93	1345	11.6	7.9	8.7	25	4.30	489	460	94.60	92	118	10	0.90	75.0	<0.1	
TC10	3/8/93	1330	12.0	7.3	8.6	14	3.40	297	358	12.50	130	207	10		40.0		
TC10	3/22/93	1050	12.0	7.5	9.2	7	4.70	174	506	8.70	79	93	15		68.0	bdl	
TC10s	3/23/93	1255	10.6	10.4	8.8	200		216	371	483.00	88	173	25		51.0	bdl	7.10
TC10	4/2/93	0920	10.3	7.0	8.8	6	3.20	309	280	7.20	130	197	5	1.40	28.0	bdl	
TC10	4/19/93	0917	11.8	7.2	8.2	2	3.00	162	509	2.70	60	78	5	0.60	57.0	bdl	
TC10	5/3/93	1420	14.4	8.2	7.7	4	2.50	169	419	2.80	82	118	5		48.0	bdl	
TC10	5/17/93	0945	15.5	8.5	7.7	2	0.78	121	471	3.70	46	70	10		44.0	bdl	
TC10	5/31/93	0915	16.9	9.4	8.5	6	0.81	142	396	3.90	44	70	10		32.0		
TC10	6/14/93	0920	17.3	8.9	7.3	4	1.10	132	342	5.50	42	69	10	bdl	39.0	bdl	
TC10	6/28/93	0850	16.3	7.7		3	1.20	308		15.00	65	70	15	6.00	47.0	bdl	
TC10	7/6/93	1330	20.5	7.3	6.4	12	2.00	229	393	6.60	96	138	10	2.00	48.0	bdl	
TC10	7/19/93	0945	20.6	7.9	7.3	8	0.50	211	357	2.90	67	114	5	bdl	33.0	bdl	
TC10	8/9/93	1317	19.7	7.9	8.4	3	0.91	225	380	5.30	90	135	10	bdl	44.0	bdl	
TC10	8/23/93	1030	20.0	8.0	7.9	2	1.20	203	450	1.60	76	110	10		47.0	bdl	
TC10	9/7/93	1219	19.0	7.7	8.1	2		186	509	3.80	75	100	10	bdl	64.0	bdl	
TC10	9/21/93	0856	17.3	7.5	8.2	3	0.60	291	423	2.60	120	178	10		20.0	bdl	
TC10	10/7/93	1045	14.6	7.3	9.1	11	0.67	238	408	8.20	84	130	10		33.0	bdl	
TC10	10/18/93	1238	15.7	8.3	8.7	5	0.89	212	440	2.00	70	123	10	0.30	55.0	bdl	
TC10	11/4/93	1236	11.6	7.9	8.1	4		244	444	3.40	110	135	10		58.0	bdl	
TC10	11/15/93	1109	14.9	8.0	5.8	bdl	0.58	271	431	15.10	120	149	10		76.0	bdl	
TC10	11/29/93	1443	8.9	8.3	8.3	bdl	1.00	235	438	4.10	bdl	126	10		82.0	bdl	
TC10s	12/5/93	0903	10.7	7.5	8.2	bdl	4.30	140	556	15.60	55	76	15		32.0	bdl	1.60
TC10	12/13/93	1017	7.9	7.9	7.9	bdl	0.87	204	480	bdl	93	109	10		74.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
TC10	1/11/93	22.51	2.50	2.00	2.80	1.49	12.00	0.42	<0.02	1.00	35.99		1.46	0.99	<0.1	<0.1	<0.3	
TC10	1/25/93	44.23	1.30	4.40	4.10		75.00	0.81	0.42	1.20	28.67			0.99	<0.1	<0.1	<0.3	
TC10	2/8/93	46.19	1.20	3.80	5.11		120.00	0.92	0.37	1.20	14.03			1.11	<0.1	<0.1	<0.3	
TC10	2/22/93	32.43	2.60	2.60	3.60	2.04	22.00	8.46	<0.02	1.50	45.75		2.14	1.05	<0.1	<0.1	<0.3	
TC10	3/8/93	49.00	1.80	4.40	5.70	2.94	119.00	1.50		0.80	24.40		3.34	1.14	0.30			
TC10	3/22/93	28.10	2.30	1.20	1.60	1.68	16.00	0.65	bdl	2.20	4.76		1.77	1.05	bdl	bdl	bdl	
TC10s	3/23/93	34.00	0.92	bdl	2.30	1.98	96.00	1.00	bdl	5.00	31.11		3.19	1.61	0.20	bdl	bdl	
TC10	4/2/93	47.60	1.50	2.70	5.90	2.77	120.00	1.30	bdl	1.00	17.08		3.12	1.13	0.30	bdl	bdl	
TC10	4/19/93	20.80	1.90	1.90	3.00	1.36	13.00	1.20	0.33	1.10	34.77		1.48	1.09	0.20	bdl	bdl	
TC10	5/3/93	29.70	1.90	2.50	3.80	1.85	51.00	bdl	bdl	0.60	29.28		2.04	1.10	bdl	bdl	bdl	
TC10	5/17/93	16.10	1.50	2.70	5.10	1.19	17.00	0.52	bdl	0.70	26.84		1.26	1.06	bdl	bdl	bdl	
TC10	5/31/93	13.50	2.40	4.10	6.90	1.27	21.00	0.58	0.37	0.90	19.52		1.12	0.88				
TC10	6/14/93	14.80	1.30	4.20	5.90	1.21	17.00	1.10	bdl	1.00	23.79		1.18	0.98	bdl	bdl	bdl	
TC10	6/28/93	23.00	1.70	4.00	5.50	1.62	bdl	6.43	bdl	0.77	28.67		1.08	0.67	0.35	bdl	bdl	
TC10	7/6/93	34.00	2.60	3.20	4.20	2.16	62.00	0.60	bdl	2.20	29.28		2.32	1.07	bdl	bdl	bdl	
TC10	7/19/93	23.40	2.20	4.90	6.90	1.74	54.00	1.20	0.18	1.10	20.13		1.86	1.06	0.30	bdl	bdl	
TC10	8/9/93	32.30	2.30	7.90	4.70	2.28	58.00	1.40	0.27	1.40	26.84		2.17	0.95	0.20	bdl	bdl	
TC10	8/23/93	26.50	2.50	6.00	5.70	1.94	39.00	1.00	bdl	0.90	28.67		1.81	0.93	0.20	bdl	bdl	
TC10	9/7/93	25.00	3.10	5.20	5.00	1.87	21.00	1.20	bdl	0.80	39.04		1.77	0.95	0.20	bdl	bdl	
TC10	9/21/93	44.40	3.40	4.70	5.80	2.86	100.00	4.50	bdl	2.70	12.20		2.65	0.93	0.40	bdl	bdl	
TC10	10/7/93	28.10	3.30	6.30	6.70	2.15	59.00	4.10	bdl	1.70	20.13		2.02	0.97	0.30	bdl	bdl	
TC10	10/18/93	23.20	3.00	17.00	7.80	2.35	35.00	1.60	bdl	1.60	33.55		1.92	0.82	0.40	bdl	bdl	
TC10	11/4/93	34.70	5.10	3.00	5.80	2.43	49.00	0.99	bdl	1.00	35.38		2.24	0.92	0.20	bdl	bdl	
TC10	11/15/93	39.30	5.30	4.10	6.10	2.73	45.00	1.40	bdl	1.90	46.36		2.55	0.93	0.30	bdl	bdl	
TC10	11/29/93	33.00	4.70	4.20	5.60	2.36	22.00	5.10	bdl	1.20	50.02		2.24	0.95	0.40	bdl	bdl	
TC10s	12/5/93	17.00	2.80	3.40	3.20	1.32	27.00	1.70	bdl	1.10	19.50		1.27		0.20	bdl	bdl	bdl
TC10	12/13/93	30.70	4.00	3.80	4.40	2.14	19.00	0.81	bdl	1.20	45.14		1.94	0.91	0.30	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TC10	1/11/93	0.02	<0.01			<0.01	<0.01	0.01		0.04		<0.01	<0.1	<0.1	3.90		<0.01		0.02	0.13	0.04	0.04
TC10	1/25/93	0.19	0.02			0.01	<0.01	0.09		<0.01		<0.01	0.10	<0.1	5.70		<0.01		0.01	0.49	0.04	0.75
TC10	2/8/93	0.12	0.01			<0.01	<0.01	0.21		0.05		<0.01	<0.1	<0.1	5.00		<0.01		0.02	0.82	0.05	0.51
TC10	2/22/93	0.05	<0.01			<0.01	<0.01	0.03		0.01		<0.01	<0.1	<0.1	3.50		<0.01		<0.01	0.61	0.04	1.60
TC10	3/8/93	0.05				0.01		0.21		0.05		0.02			3.80					0.52	0.06	0.29
TC10	3/22/93	bdl	bdl			bdl	bdl	bdl		0.02		bdl	bdl	bdl	3.20		bdl		0.01	0.10	0.02	0.05
TC10s	3/23/93	0.39	bdl	0.02		bdl	bdl	0.03		bdl		2.60	bdl	bdl	4.40	0.09	bdl	bdl	0.01	3.10	0.25	3.30
TC10	4/2/93	0.05	bdl			bdl	bdl	0.21		0.04		bdl	bdl	bdl	5.40		bdl		0.01	0.36	0.04	0.14
TC10	4/19/93	0.06	bdl			bdl	bdl	0.02		0.02		bdl	bdl	bdl	3.90		bdl		0.02	0.16	0.02	0.08
TC10	5/3/93	0.06	bdl			bdl	bdl	0.04		0.05		bdl	bdl	bdl	4.30		bdl		0.01	0.27	0.05	0.16
TC10	5/17/93	0.19	bdl			bdl	bdl	0.04		0.01		bdl	bdl	bdl	4.50		bdl		0.02	0.16	0.02	0.21
TC10	5/31/93	0.33					0.02	0.39							4.90				0.05	0.24	0.02	0.44
TC10	6/14/93	0.26	bdl			0.01	bdl	0.01		bdl		bdl	bdl	bdl	4.90		bdl		bdl	0.22	0.03	0.32
TC10	6/28/93	0.14	bdl			bdl	0.01	0.05		0.04		bdl	bdl	bdl	4.60		bdl		0.06	0.37	0.04	0.31
TC10	7/6/93	0.07	bdl			bdl	0.01	0.08		0.07		bdl	bdl	bdl	4.50		bdl		bdl	0.51	0.07	0.20
TC10	7/19/93	0.06	bdl			bdl	bdl	bdl		0.09		bdl	bdl	bdl	4.60		bdl		0.01	0.35	0.10	0.19
TC10	8/9/93	0.10	0.02			bdl	bdl	0.12		0.09		bdl	bdl	bdl	4.60		bdl		0.03	0.39	0.09	0.19
TC10	8/23/93	0.09	0.02			bdl	bdl	0.03		0.08		bdl	bdl	bdl	4.80		bdl		0.01	0.26	0.08	0.15
TC10	9/7/93	0.09	0.02			bdl	bdl	0.04		0.09		bdl	bdl	bdl	4.50		bdl		bdl	0.22	0.09	0.10
TC10	9/21/93	0.07	0.02				bdl	0.08		0.12		bdl	bdl	bdl	5.60		bdl		0.03			
TC10	10/7/93	0.04	0.03			bdl	bdl	0.08		0.03		bdl	bdl	bdl	6.70		bdl		0.02	0.26	0.04	0.23
TC10	10/18/93	0.07	0.06			bdl	bdl	0.03		0.07		bdl	bdl	bdl	5.70		bdl		0.01	0.22	0.07	0.18
TC10	11/4/93	0.03	0.04			bdl	0.02	0.02		0.08		bdl	bdl	bdl	4.60		bdl		0.02	0.15	0.09	0.17
TC10	11/15/93	0.03	0.02			bdl	bdl	0.02		0.08		0.01	bdl	bdl	4.20		bdl		0.03	0.35	0.09	0.25
TC10	11/29/93	0.04	0.02			bdl	0.02	0.03		0.07		bdl	bdl	bdl			bdl		0.02	0.21	0.07	0.04
TC10s	12/5/93	0.09	0.02	0.02	bdl	bdl	bdl	0.05	0.96	0.06	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.26	0.07	0.25
TC10	12/13/93	0.03	0.02	bdl	bdl	bdl	bdl	0.04	bdl	0.07	bdl	bdl	bdl	bdl			bdl	bdl	0.02	0.17	0.07	0.05

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
TD1	1/11/93	1415	10.2	7.3	5.5	7	0.04	285	530	5.10	150	159	30	0.80	130.0	<0.1	
TD1	1/25/93	1430	8.4	7.6	5.3	3	0.06	287	422	5.40	150	160	<5		130.0	<0.1	
TD1	2/8/93	1300	9.9	7.7	6.7	2	0.01	267	469	6.10	140	151	10	0.30	130.0	<0.1	
TD1	2/22/93	0945	9.2	7.9	6.5	6	0.06	242	491	4.60	140	152	15		230.0	<0.1	
TD1	3/8/93	1030	10.3	7.6	6.6	2	0.06	248	510	1.90	140	163	10		140.0		
TD1	3/22/93	1420	11.5	7.1	6.3	10	0.18	241	456	24.70	140	148	10		110.0	bdl	
TD1s	3/23/93	1445	12.7	7.6	8.4	200	6.60	223	432	287.00	110	127	35		96.0	bdl	8.70
TD1	4/2/93	1340	9.8	7.2	6.3	12	0.02	275	397	12.90	140	146	5		110.0	bdl	
TD1	4/19/93	1329	14.6	7.4	4.5	14	0.80	250	433	27.70	140	150	25	2.30	120.0		
TD1	5/3/93	1040	13.6	7.7	4.8	2	bdl	252	459	2.00	160	166	10		140.0	bdl	
TD1	5/17/93	1340	16.2	7.5	4.0	3	0.01	254	441	5.20	150	165	10		150.0	bdl	
TD1	5/31/93	1340	15.2	7.2	2.5	7	0.02	321	418	16.20	150	166	10		150.0	bdl	
TD1	6/14/93	1310	17.5	7.4	4.2	4	0.04	332	410	2.70	170	179	10		160.0	bdl	
TD1	7/6/93	1030	18.3	7.3	3.7	4	bdl	331	355	3.80	180	189	10		170.0	bdl	
TD1	7/19/93	1515	19.8	7.5	4.8	7	0.01	365	379	5.00	180	177	5	4.00	170.0	bdl	
TD1	8/9/93	1143	18.4	7.5	5.0	4	bdl	350	282	6.10	180	164	10	bdl	130.0	bdl	
TD1	8/23/93	1425	19.5	7.7	4.3	4	0.01	366	421	4.00	190	195	10	bdl	170.0	bdl	
TD1	9/7/93	1518	19.1	7.3	3.9	7		376	423	31.50	140	172	10		170.0	bdl	
TD1	10/7/93	0952	14.2	7.4	5.0	10	bdl	373	385	17.60	190	193	10		160.0	bdl	
TD1	10/18/93	1047	14.9	7.5	5.6	5	0.01	379	422	8.80	200	202	10		160.0	bdl	
TD1	11/4/93	1507	11.6	7.4	6.1	5		395	353	9.70	200	205	15		160.0	bdl	
TD1	11/15/93	1013	12.0	7.5	6.7	bdl	0.04	382	401	12.90	190	199	10		140.0	bdl	
TD1	11/29/93	0841	8.8	7.7	7.4	bdl		346	425	21.70	180	170	10		120.0	bdl	
TD1s	12/5/93	1039	13.2	7.9	8.9	bdl	3.00	258	464	27.30	140	135	75		110.0	bdl	4.60
TD1	12/13/93	1320	10.5	7.6	8.2	bdl	0.08	283	439	10.90	150	147	10		120.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
TD1	1/11/93	53.36	5.00	1.70	1.00	3.17	17.00	0.77	<0.02	1.60	79.30		3.03	0.96	0.30	<0.1	<0.3	
TD1	1/25/93	52.31	4.80	1.70	0.90		19.00	0.96	<0.02	1.50	79.30			0.99	<0.1	<0.1	<0.3	
TD1	2/8/93	49.24	4.60	1.70	1.00		14.00	0.83	<0.02	1.40	79.30			1.00	0.30	<0.1	<0.3	
TD1	2/22/93	50.32	4.60	1.30	0.90	2.96	21.00	1.05	<0.02	1.80	140.30		2.89	0.97	<0.1	<0.1	<0.3	
TD1	3/8/93	48.50	4.20	1.40	0.70	2.84	20.00	1.40		1.90	85.40		3.31	1.17	0.40			
TD1	3/22/93	47.60	4.20	2.90	0.80	2.86	22.00	2.20	bdl	2.60	67.10		2.76	0.97	0.20	bdl	bdl	
TD1s	3/23/93	39.00	2.60	0.90	2.30	2.29	21.00	3.10	bdl	bdl	58.56		2.42	1.06	0.20	bdl	bdl	
TD1	4/2/93	48.40	4.20	1.30	0.90	2.83	22.00	1.10	0.35	1.50	67.10		2.74	0.97	0.20	bdl	bdl	
TD1	4/19/93	49.20	4.10	1.40	0.50	2.86	20.00	0.57	0.70	1.40	12.20		2.87	1.00	0.20		bdl	
TD1	5/3/93	56.40	4.50	1.60	0.40	3.26	17.00	0.31	0.52	1.20	85.40		3.20	0.98	bdl	bdl	bdl	
TD1	5/17/93	52.90	4.30	1.70	0.50	3.07	13.00	0.51	0.54	1.40	91.50		3.34	1.09	0.10	bdl	bdl	
TD1	5/31/93	53.60	4.40	1.90	0.80	3.13	13.00	0.65	0.52	1.50	91.50		3.33	1.06	bdl	bdl	bdl	
TD1	6/14/93	61.00	5.10	2.10	0.70	3.57	11.00	0.69	0.54	1.60	97.60		3.51	0.98	0.20	bdl	bdl	
TD1	7/6/93	62.30	5.80	2.90	1.00	3.74	13.00	0.20	bdl	1.60	103.70		3.73	1.00	0.20	bdl	bdl	
TD1	7/19/93	64.30	5.50	2.80	0.90	3.80	1.30	bdl	bdl	bdl	103.70		3.43	0.90	bdl	bdl	bdl	
TD1	8/9/93	64.10	5.70	2.80	0.70	3.80	9.50	0.36	bdl	2.10	79.30		2.87	0.76	0.20	bdl	bdl	
TD1	8/23/93	65.10	5.70	2.70	1.00	3.85	16.00	0.19	bdl	2.00	103.70		3.81	0.99	0.30	bdl	bdl	
TD1	9/7/93	45.00	6.00	2.90	0.70	2.88	13.00	0.27	bdl	2.20	103.70		3.75	1.30	0.20	bdl	bdl	
TD1	10/7/93	66.60	6.30	2.90	1.00	3.99	17.00	0.15	bdl	2.20	97.60		3.63	0.91	0.30	bdl	bdl	
TD1	10/18/93	70.80	6.50	2.90	0.90	4.21	22.00	0.16	bdl	2.40	97.60		3.74	0.89	0.20	bdl	bdl	
TD1	11/4/93	69.50	6.40	2.90	1.00	4.14	25.00	1.20	bdl	2.40	97.60		3.82	0.92	0.30	bdl	bdl	
TD1	11/15/93	66.50	6.50	2.70	1.20	4.00	32.00	2.30	bdl	3.20	85.40		3.61	0.90	0.30	bdl	bdl	
TD1	11/29/93	61.10	5.80	2.20	1.00	3.64	24.00	1.30	bdl	2.00	73.20		2.99	0.82	0.30	bdl		
TD1s	12/5/93	50.00	3.00	0.49	0.91	2.81	12.00	0.79	bdl	1.30	67.10		2.51		0.20	bdl	bdl	bdl
TD1	12/13/93	51.90	4.00	0.80	0.90	2.98	15.00	0.59		1.50	73.20		2.78	0.93	0.20	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TD1	1/11/93	<0.01	<0.01		bdl	<0.01	<0.01	0.05		0.01	bdl	<0.01	<0.1	<0.1	2.70		<0.01		<0.01	0.20	0.02	<0.01
TD1	1/25/93	<0.01	<0.01			<0.01	<0.01	0.07		0.02		<0.01	<0.1	<0.1	2.70		<0.01		<0.01	0.14	0.03	<0.01
TD1	2/8/93	<0.01	<0.01			0.02	<0.01	0.04		0.01		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.10	0.01	<0.01
TD1	2/22/93	<0.01	<0.01			<0.01	<0.01	0.02		<0.01		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.12	<0.01	0.02
TD1	3/8/93							0.23							2.80					0.08	0.01	
TD1	3/22/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	3.10		bdl		bdl	0.26	0.03	0.13
TD1s	3/23/93	0.23	0.01	0.02		bdl	bdl	0.23		bdl		bdl	bdl	bdl	2.40	0.08	0.03	bdl	bdl	0.39	0.22	0.77
TD1	4/2/93	bdl	bdl			bdl	bdl	0.03		0.01		bdl	bdl	bdl	2.80		bdl		0.01	0.11	0.03	0.02
TD1	4/19/93							0.05		0.02		bdl	bdl	bdl	2.80		bdl		bdl	0.40	0.04	0.04
TD1	5/3/93	bdl	bdl			bdl	bdl	0.05		0.02		bdl	bdl	bdl	3.00		bdl		0.01	0.11	0.02	0.04
TD1	5/17/93	bdl	bdl			bdl	bdl	0.05		0.02		bdl	bdl	bdl	2.90		bdl		0.02	0.13	0.02	0.02
TD1	5/31/93	bdl	bdl			bdl	bdl	0.09		0.03		bdl	bdl	bdl	3.00		bdl		0.04	0.23	0.03	0.13
TD1	6/14/93	0.01	bdl			bdl	bdl	0.13		0.04		bdl	bdl	bdl	3.50		bdl		0.03	0.15	0.04	0.06
TD1	7/6/93	bdl	bdl			bdl	bdl	0.17		0.06		bdl	bdl	bdl	3.60		bdl		0.01	0.22	0.06	0.06
TD1	7/19/93	bdl	bdl			bdl	0.01	0.07		0.05		bdl	bdl	bdl	3.50		bdl		bdl	0.25	0.05	bdl
TD1	8/9/93	bdl	0.01			bdl	bdl	0.02		0.04		bdl	bdl	bdl	3.50		bdl		bdl	0.17	0.05	0.01
TD1	8/23/93	bdl	bdl			bdl	bdl	0.05		0.05		bdl	bdl	bdl	3.60		bdl		bdl	0.14	0.05	0.01
TD1	9/7/93	bdl	0.02			bdl	bdl	0.06		0.07		bdl	bdl	bdl	3.60		bdl		bdl	0.58	0.10	0.10
TD1	10/7/93	bdl	bdl			bdl	bdl	0.09		0.06		bdl	bdl	bdl	3.40		bdl		0.02	0.89	0.89	0.02
TD1	10/18/93	bdl	0.01			bdl	bdl	0.10		0.05		bdl	bdl	bdl	3.40		bdl		0.02	0.40	0.07	bdl
TD1	11/4/93	bdl	0.01			bdl	bdl	0.10		0.04		bdl	bdl	bdl	3.20		bdl		0.02	0.70	0.08	bdl
TD1	11/15/93	bdl	bdl			bdl	bdl	0.12		0.03		bdl	bdl	bdl	3.00		bdl		0.03	0.45	0.05	0.07
TD1	11/29/93	bdl	bdl			bdl	bdl	0.14		0.03		0.01		bdl			bdl		bdl	0.56	0.06	0.05
TD1s	12/5/93	0.24	bdl	0.02	bdl	bdl	bdl	0.16	0.89	bdl	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.37	0.02	0.49
TD1	12/13/93	0.05	bdl	bdl	bdl	bdl	bdl	0.06	bdl	0.01	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.19	0.02	0.05

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
YC5	1/11/93	1020	7.7	7.0	9.4	3	11.30	41	495	1.30	15	21	10		6.5	<0.1	
YC5	1/25/93	1230	7.0	7.9	9.9	2	19.50	38	426	4.20	14	21	15		5.2	<0.1	
YC5	2/8/93	1150	4.9	7.1	10.9	1	2.10	46	460	1.80	17	24	10		8.3	<0.1	
YC5	2/22/93	1425	7.3	7.5	10.3	2		27	444	4.10	13	18	5		4.7	<0.1	
YC5	3/8/93	1350	8.1	6.9	9.5	2	11.50	35	452	0.90	14	21	5		7.3		
YC5	3/22/93	1115	7.5	7.3	9.9	2	31.00	37	498	3.90	14	22	10		3.9		
YC5s	3/23/93	1300	7.3	7.6	9.7	200		33	488	123.00	15	22	25		3.4	bdl	6.20
YC5	4/2/93	1100	10.0	7.2	9.0	13	11.00	40	415	7.70	14	22	10	bdl	4.5		
YC5	4/19/93	0938	13.2	6.9	7.9	5	5.20	37	500	3.70	15	26	5		6.7	bdl	
YC5	5/3/93	1430	16.7	7.3	7.8	2	4.30	39	454	bdl	16	23	15		7.0	bdl	
YC5	5/17/93	1010	17.0	7.3	5.5	3	0.83	57	525	2.30	27	34	20	bdl	18.0		
YC5	5/31/93	0945	18.5	7.5	7.0	4	0.64	98	425	1.70	28	35	25		21.0		
YC5	6/14/93	0935	19.4	6.3	5.3	2	0.09	86	465	4.10	37	49	20		36.0		
YC5	7/6/93	1400	23.8	7.7	3.9	2	0.18	97	437	0.90	45	49	10		38.0		
YC5	7/19/93	1135	23.2	7.3	6.8	5	0.20	106	372	1.10	48	52	20	bdl	37.0	bdl	
YC5	8/9/93	1344	22.4	7.1	4.5	2	0.05	82	362	3.30	38	42	10	bdl	31.0	bdl	
YC5	8/23/93	1055	21.6	7.4	4.6	1	0.50	100	452	6.20	47	51	20		36.0		
YC5	9/7/93	1219	19.0	7.7	8.1	2		186	509	6.70	39	43	30		32.0		
YC5	9/21/93	0904	18.0	7.2	3.9	2	0.23	103	439	12.30	51	54	15		38.0	bdl	
YC5	10/7/93	1105	14.3	6.8	5.5	5	0.12	104	428	3.30	48	52	20	bdl	38.0	bdl	
YC5	10/18/93	1252	15.5	6.8	3.9	1	0.21	119	434	12.60	57	58	30		40.0	bdl	
YC5	11/4/93	1251	8.6	6.7	7.1	1		114	422	4.40	54	58	30		39.0	bdl	
YC5	11/15/93	1129	14.4	6.7	5.3	bdl	0.60	121	411	3.20	54	58	30		38.0	bdl	
YC5	11/29/93	1457	6.2	7.0	7.9	bdl		128	428	2.60	55	64	15		29.0	bdl	
YC5s	12/5/93	0914	9.6	6.9	10.1	bdl		40	534	15.00	15	19	20		6.1	bdl	1.80
YC5	12/13/93	1038	6.7	6.9	10.2	bdl	9.30	44	423	2.30	17	21	10		7.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
YC5	1/11/93	2.91	1.9	0.7	1	0.37	8.4	0.91	<0.02	1	3.97		0.35	0.94	<0.1	<0.1	0.3	
YC5	1/25/93	2.48	1.9	0.7	0.9		8.5	1.77	<0.02	0.7	3.17			1.01	<0.1	<0.1	<0.3	
YC5	2/8/93	3.52	2	0.8	1		9.5	1	<0.02	0.8	5.06			1	<0.1	<0.1	<0.3	
YC5	2/22/93	2.3	1.9	0.6	0.9	0.32	8.4	<0.05	<0.02	0.9	2.87		0.29	0.91	<0.1	<0.1	<0.3	
YC5	3/8/93	2.6	1.9	0.7	0.7	0.34	9.9			0.5	4.45		0.37	1.09				
YC5	3/22/93	2.52	1.9	0.8	0.7	0.34	12	1.2		0.7	32.94		0.37	1.08			bdl	
YC5s	3/23/93	3.20	1.60	0.70	1.50	0.37	12.00	bdl	bdl	0.80	2.07		0.34	0.93	bdl	bdl	bdl	
YC5	4/2/93	2.51	1.9	0.5	0.9	0.34	11	0.6	0.95	0.5	2.75		0.36	1.08	bdl		bdl	
YC5	4/19/93	2.97	1.9	0.6	0.7	0.35	13	1.6	bdl	0.6	4.09		0.45	1.26	bdl	bdl	bdl	
YC5	5/3/93	3.19	2	0.7	0.9	0.38	10	0.22	0.46	0.9	4.27		0.39	1.01	bdl		bdl	
YC5	5/17/93	6.55	2.6	0.8	1.1	0.61	11	0.55	bdl	0.6	10.98		0.61	1.01	bdl	bdl	bdl	
YC5	5/31/93	7.12	2.5	0.7	1.2	0.63	8.7	0.68	0.89	0.7	12.81		0.65	1.04				
YC5	6/14/93	10	2.9	0.8	1.2	0.83	7.5	3.9	bdl	0.7	21.96		0.96	1.16	bdl		bdl	
YC5	7/6/93	12.4	3.3	0.8	1.5	0.97	6.9	0.54	bdl	0.7	23.18		0.93	0.96	bdl	bdl	bdl	
YC5	7/19/93	13.4	3.4	0.9	1.4	1.03	9.3	0.5	bdl	0.6	22.57		0.96	0.93	bdl	bdl	bdl	
YC5	8/9/93	10.8	2.6	1.1	1.4	0.85	5.6	0.19	bdl	0.7	18.91		0.77	0.9	0.1	bdl	bdl	
YC5	8/23/93	13.5	3.1	1	1.7	1.03	9.2	bdl	bdl	0.7	21.96		0.94	0.91	0.1		bdl	
YC5	9/7/93	11	2.8	0.9	1.4	0.87	6	0.46	bdl	0.6	19.52		0.82	0.94	0.5	bdl	bdl	
YC5	9/21/93	14.7	3.4	0.9	1.9	1.11	8.3	0.14	bdl	0.9	23.18		0.97	0.88	0.2	bdl	bdl	
YC5	10/7/93	14.1	3.2	1.1	1.9	1.07	6.7	0.65	bdl	0.9	23.18		0.94	0.88	0.1	bdl	bdl	
YC5	10/18/93	16.5	3.7	1	2.4	1.24	8.8	bdl	bdl	1.1	24.4		1.03	0.82	0.2	bdl	bdl	
YC5	11/4/93	15.7	3.5	1.1	2.1	1.18	10	0.14	bdl	1.3	23.79		1.04	0.88	0.2	bdl	bdl	
YC5	11/15/93	16.2	3.2	1	2.6	1.19	9.9	0.17	bdl	1.4	23.18		1.02	0.86	0.2	bdl	bdl	
YC5	11/29/93	15.1	4.1	1.3	1.6	1.2	22	0.3	bdl	1.2	17.69		1.08	0.9	0.1	bdl	bdl	
YC5s	12/5/93	2.80	2.00	0.60	0.86	0.36	7.70	0.16	bdl	0.60	3.72		0.30		bdl	bdl	bdl	0.39
YC5	12/13/93	3.55	2	0.6	1.1	0.41	8.5	0.18	bdl	0.7	4.27		0.34	0.83	bdl	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
YC5	1/11/93	0.04	0.01			<0.01	<0.01	0.15		0.03		<0.01	<0.1	<0.1	2.50		<0.01		<0.01	0.19	0.03	0.04
YC5	1/25/93	<0.01	0.01			<0.01	<0.01	0.11		0.03		<0.01	<0.1	<0.1	2.40		<0.01		<0.01	0.20	0.03	0.05
YC5	2/8/93	<0.01	0.01			<0.01	<0.01	0.12		0.04		<0.01	<0.1	<0.1	2.40		<0.01		0.01	0.18	0.04	0.06
YC5	2/22/93	<0.01	<0.01			0.03	<0.01	0.08		0.02		<0.01	<0.1	<0.1	2.30		<0.01		<0.01	0.20	0.02	0.06
YC5	3/8/93							0.09		0.02		0.01			2.30		8.00		0.01	0.16	0.02	0.05
YC5	3/22/93	0.02						0.06		0.02		0.02			2.30		bdl		0.01	0.14	0.03	0.06
YC5s	3/23/93	0.03	0.01	0.02		0.02	bdl	0.09		0.04		bdl	bdl	0.02	2.10	0.01	bdl	0.05	0.02	1.40	0.32	0.54
YC5	4/2/93	0.06				bdl	bdl	0.09		0.03		bdl	bdl	bdl	2.10		bdl		0.05	0.12	0.04	0.07
YC5	4/19/93	0.02	0.01			bdl	bdl	0.11		0.03		bdl	bdl	bdl	2.00		bdl		0.01	0.25	0.03	0.14
YC5	5/3/93	0.02	bdl			0.02	bdl	0.09		0.02		bdl	bdl	bdl	1.80		bdl		0.01	0.15	0.03	0.05
YC5	5/17/93	0.02	bdl			bdl	bdl	0.16		0.05		bdl	bdl	bdl	2.10		bdl		0.02	0.28	0.05	0.02
YC5	5/31/93		0.03					0.19		0.06					2.50		bdl		0.04	0.32	0.06	0.07
YC5	6/14/93	0.05				bdl	bdl	0.28		0.11		bdl	bdl	bdl	3.00		bdl		0.03	0.74	0.29	0.13
YC5	7/6/93	bdl	bdl			bdl	bdl	0.25		0.10		bdl	bdl	bdl	3.10		bdl		bdl	0.89	0.53	0.08
YC5	7/19/93	bdl	0.02			bdl	bdl	0.26		0.05		bdl	bdl	bdl	2.90		bdl		bdl	0.34	0.05	0.02
YC5	8/9/93	bdl	0.01			bdl	bdl	0.30		0.06		bdl	bdl	bdl	2.90		bdl		0.02	0.42	0.09	0.03
YC5	8/23/93		0.01			bdl	bdl	0.29		0.10		bdl	bdl	bdl	3.20		bdl		bdl	0.46	0.10	0.02
YC5	9/7/93	bdl	0.01			bdl	0.01	0.34		0.08		bdl	bdl	bdl	3.20		bdl		bdl	0.46	0.09	bdl
YC5	9/21/93	bdl	bdl			bdl	0.01	0.20		0.05		bdl	bdl	bdl	3.20		bdl		0.02	0.32	0.05	bdl
YC5	10/7/93	bdl	0.01			bdl	bdl	0.21		0.05		bdl	bdl	bdl	3.20		bdl		0.02	0.33	0.05	bdl
YC5	10/18/93	bdl	0.02			bdl	bdl	0.30		0.10		bdl	bdl	bdl	3.50		bdl		0.02	0.48	0.10	bdl
YC5	11/4/93	bdl	0.02			bdl	bdl	0.33		0.05		bdl	bdl	bdl	3.50		bdl		0.03	0.47	0.05	bdl
YC5	11/15/93	0.04	bdl			bdl	bdl	0.24		0.03		bdl	bdl	bdl	3.10		bdl		0.03	0.38	0.03	0.10
YC5	11/29/93	0.02	0.01			bdl	bdl	0.36		0.05		bdl	bdl	bdl	bdl		bdl		bdl	0.46	0.05	0.07
YC5s	12/5/93	0.02	0.02	0.02	bdl	bdl	bdl	0.18	0.83	0.09	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.41	0.11	0.15
YC5	12/13/93	0.04	bdl	bdl	bdl	bdl	bdl	0.19	bdl	0.06	bdl	bdl	bdl	bdl			bdl	bdl	0.01	0.35	0.07	0.16

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
YC5A	1/11/93	1000	8.7	7.0	9.1	6	11.70	78	540	4.80	25	32	10	0.40	14.0	<0.1	
YC5A	1/25/93	1215	7.5	8.8	9.4	18	29.70	121	449	5.10	48	65	20	2.00	19.0	<0.1	
YC5A	2/8/93	1145	6.5	7.5	10.5	6	4.10	183	413	9.00	70	100	10	1.30	15.0	<0.1	
YC5A	2/22/93	1420	8.5	7.3	9.7	7	44.00	193	454	9.80	63	78	5	0.30	10.0	<0.1	
YC5A	3/8/93	1340	9.2	7.0	9.4	4	14.70	114	416	5.10	65	100	5	0.50	16.0		
YC5A	3/22/93	1100	9.3	7.5	9.5	5	44.00	96	497	9.20	42	55	15	0.30	22.0		
YC5As	3/23/93	1310	8.0	8.1		425		9	75	150.00	21	33	30		12.0	bdl	8.60
YC5A	4/2/93	0940	10.4	7.2	8.6	12	19.80	41	375	8.90	16	22	10	1.00	4.9	bdl	
YC5A	4/19/93	0929	12.6	6.9	8.3	3	8.00	95	503	4.10	46	67	5	0.60	20.0	bdl	
YC5A	5/3/93	1425	15.6	7.8	7.8	2	6.20	105	430	1.10	52	72	10		26.0	bdl	
YC5A	5/17/93	1000	15.8	8.2	7.1	3	2.20	122	486	1.00	40	56	10		28.0	bdl	
YC5A	5/31/93	0930	17.1	9.3	7.5	7	3.30	134	369	5.20	38	59	10		36.0		
YC5A	6/14/93	0930	17.5	9.0	7.4	3	1.10	128	353	2.80	46	70	10		40.0	bdl	
YC5A	7/6/93	1350	20.7	7.6	6.2	5	0.50	235	399	5.30	91	128	10	1.00	49.0	bdl	
YC5A	7/19/93	1040	21.7	7.5	7.1	4	0.30	179	241	2.30	65	100	10	bdl	36.0	bdl	
YC5A	8/9/93	1340	19.9	7.8	6.9	3	0.61	228	347	4.40	86	125	10	bdl	42.0	bdl	
YC5A	8/23/93	1050	20.2	7.8	7.7	3	0.93	188	432	2.20	74	116	10	bdl	63.0	bdl	
YC5A	9/7/93	1233	19.2	7.5	7.1	3		185	511	503.00	73	96	10	bdl	62.0	bdl	
YC5A	9/21/93	0859	17.4	7.4	8.3	3	0.69	286	419	2.20	120	176	10		20.0	bdl	
YC5A	10/7/93	1058	14.7	7.3	8.7	8	0.60	236	406	5.30	82	126	10		18.0		
YC5A	10/18/93	1247	15.7	7.9	8.4	3	0.70	209	443	3.70	68	108	15	bdl	51.0	bdl	
YC5A	11/4/93	1245	11.2	7.5	9.2	2		225	432	3.00	110	131	10		57.0	bdl	
YC5A	11/15/93	1120	14.8	7.6	7.4	bdl	1.20	235	407	8.80	90	109	15		62.0	bdl	
YC5A	11/29/93	1446	8.4	8.1	10.2	bdl		227	434	4.00	98	118	bdl		78.0	bdl	
YC5As	12/5/93	0910	9.9	7.1	9.6	bdl		65	544	17.20	23	30	15		11.0		2.20
YC5A	12/13/93	1028	7.0	7.4	10.5	bdl	9.00	104	417	1.70	17	27	10		16.0	bdl	bdl

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
YC5A	1/11/93	6.69	2.00	0.90	1.20	0.58	11.00	0.26	<0.02	1.20	8.54		0.55	0.94	<0.1	<0.1	<0.3	
YC5A	1/25/93	16.36	1.60	1.70	2.00		30.00	0.45	<0.02	0.90	11.59			0.97	<0.1	<0.1	<0.3	
YC5A	2/8/93	25.68	1.50	2.30	3.30		54.00	2.91	<0.02	0.90	9.15			0.94	<0.1	<0.1	<0.3	
YC5A	2/22/93	21.75	2.00	1.40	1.90	1.36	43.00	0.53	<0.02	0.90	6.10		1.13	0.83	<0.1	<0.1	<0.3	
YC5A	3/8/93	23.00	1.80	2.50	2.90	1.48	59.00	0.53		0.60	9.76		1.57	1.06	0.30			
YC5A	3/22/93	13.30	2.00		1.20	0.90	22.00	0.75	bdl	1.00	2.38		0.94	1.04				
YC5As	3/23/93	5.50	1.70	0.79	1.60	0.52	15.00	0.40	bdl	0.80	7.32		0.58	1.12	bdl	bdl	bdl	
YC5A	4/2/93	3.31	1.90	0.60	1.00	0.38	11.00	bdl	bdl	1.10	2.99		0.36	0.94	bdl	0.8	bdl	
YC5A	4/19/93	15.00	2.00	1.20	1.80	1.01	34.00	0.49	bdl	0.70	12.20		1.13	1.12	bdl	bdl	bdl	
YC5A	5/3/93	17.60	1.90	1.60	2.30	1.17	32.00	bdl	bdl	0.50	15.86		1.20	1.03	bdl	bdl	bdl	
YC5A	5/17/93	12.40	2.10	1.70	2.80	0.94	19.00	0.44	bdl	0.60	17.08		0.98	1.04	bdl	bdl	bdl	
YC5A	5/31/93	12.40	1.60	3.00	4.80	1.02	14.00	0.43		0.90	21.96		1.04	1.02				
YC5A	6/14/93	15.70	1.60	4.40	5.90	1.28	17.00	0.43	bdl	1.00	24.40		1.19	0.93	bdl	bdl	bdl	
YC5A	7/6/93	32.00	2.80	2.80	3.70	2.07	55.00	0.38	bdl	1.00	29.89		2.16	1.04	bdl	bdl	bdl	
YC5A	7/19/93	22.00	2.40	4.00	5.50	1.62	43.00	0.32	bdl	0.80	21.96		1.64	1.02	bdl	bdl	bdl	
YC5A	8/9/93	30.50	2.30	7.00	4.30	2.14	53.00	1.10	bdl	1.10	25.62		2.00	0.93	0.10	bdl	bdl	
YC5A	8/23/93	25.40	2.60	5.40	5.20	1.86	38.00	0.61	bdl	0.60	38.43		2.09	1.12	0.20	bdl	bdl	
YC5A	9/7/93	24.00	3.10	4.90	4.90	1.80	20.00	0.85	bdl	0.80	37.82		1.70	0.94	0.20	bdl	bdl	
YC5A	9/21/93	43.80	3.30	5.50	5.90	2.85	100.00	3.30	bdl	1.50	12.20		2.60	0.91	0.40	bdl	bdl	
YC5A	10/7/93	27.50	3.30	5.00	5.80	2.06	69.00	0.98	bdl	1.30	10.98		1.87	0.91	0.30	bdl	bdl	
YC5A	10/18/93	22.30	3.10	9.80	7.00	1.98	32.00	1.30	bdl	1.60	31.11		1.77	0.90	0.40	bdl	bdl	
YC5A	11/4/93	33.90	5.00	2.80	5.70	2.37	47.00	0.67	bdl	1.00	34.77		2.17	0.92	0.30	bdl	bdl	
YC5A	11/15/93	28.80	4.40	2.80	4.80	2.05	29.00	0.50	bdl	1.60	37.82		1.91	0.93	0.20	bdl	bdl	
YC5A	11/29/93	31.70	4.70	4.00	5.10	2.27	23.00	1.50	bdl	1.10	47.58		2.11	0.93	0.30	bdl	bdl	
YC5As	12/5/93	5.50	2.10	1.20	1.30	0.54	12.00	0.64	bdl	0.70	6.71		0.51		0.10	bdl	bdl	bdl
YC5A	12/13/93	3.75	1.90	0.70	1.00	0.41	8.90	0.16	bdl	0.70	9.76		0.53	1.29	0.10	bdl	bdl	bdl

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
YC5A	1/11/93	0.01	<0.01			<0.01	<0.01	0.09		0.04		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.22	0.04	0.04
YC5A	1/25/93	0.06	<0.01			<0.01	<0.01	0.04		0.02		<0.01	<0.1	<0.1	3.40		<0.01		<0.01	0.32	0.03	0.38
YC5A	2/8/93	0.02	<0.01			0.01	<0.01	0.11		0.04		<0.01	<0.1	<0.1	3.70		<0.01		0.01	0.55	0.04	0.28
YC5A	2/22/93	<0.01	<0.01			0.03	<0.01	0.06		0.02		<0.01	<0.1	<0.1	3.10		<0.01		<0.01	0.28	0.02	0.14
YC5A	3/8/93	0.02	0.01			0.01		0.11		0.03					2.80				0.01	0.30	0.04	0.17
YC5A	3/22/93					0.04		0.03		0.02					2.80		5.00		0.01	0.18	0.03	0.07
YC5As	3/23/93	0.20	bdl	0.02		bdl	0.02	0.15		0.04		bdl	bdl	bdl	2.40	0.02	bdl	bdl	0.01	1.50	0.30	0.70
YC5A	4/2/93	0.05	bdl			bdl	bdl	0.03		0.04		bdl	bdl	bdl	2.10		bdl		0.02	0.12	0.04	0.05
YC5A	4/19/93	0.01	0.02			bdl	0.01	0.10		0.05		bdl	bdl	bdl	2.80		bdl		0.01	0.47	0.06	0.14
YC5A	5/3/93	0.04	bdl			bdl	bdl	0.06		0.04		bdl	bdl	bdl	3.00		bdl		0.02	0.22	0.04	0.11
YC5A	5/17/93	0.04	bdl			bdl	bdl	0.06		0.05		bdl	bdl	bdl	3.20		bdl		0.02	0.27	0.05	0.08
YC5A	5/31/93	0.18						0.05		0.03					4.10				0.04	0.25	0.04	0.24
YC5A	6/14/93	0.18	bdl			0.01	bdl	0.03		0.03		bdl	bdl	bdl	4.70		bdl		0.03	0.23	0.04	0.20
YC5A	7/6/93	0.16	bdl			bdl	bdl	0.26		0.09		bdl	bdl	bdl	4.30		bdl		bdl	0.47	0.07	0.24
YC5A	7/19/93	0.06	0.01			bdl	bdl	0.09		0.09		bdl	bdl	bdl	4.20		bdl		bdl	0.25	0.09	0.08
YC5A	8/9/93	0.10	0.02			bdl	bdl	0.12		0.08		bdl	bdl	bdl	4.40		bdl		0.03	0.40	0.09	0.19
YC5A	8/23/93	0.09	0.02			bdl	bdl	0.03		0.08		bdl	bdl	bdl	4.60		bdl		bdl	0.31	0.09	0.15
YC5A	9/7/93	0.08	0.02			bdl	bdl	0.06		0.08		bdl	bdl	bdl	4.40		bdl		bdl	0.24	0.08	0.12
YC5A	9/21/93	0.06	0.03			bdl	0.02	0.09		0.12		bdl	bdl	bdl	5.50		bdl		0.03	0.27	0.13	0.20
YC5A	10/7/93	0.02	0.03			bdl	bdl	0.08		0.07		bdl	bdl	bdl	5.90		bdl		0.02	0.16	0.09	0.25
YC5A	10/18/93	0.04	0.05			bdl	bdl	0.06		0.07		bdl	bdl	bdl	5.40		bdl		0.01	0.23	0.07	0.17
YC5A	11/4/93	0.03	0.03			bdl	bdl	0.02		0.08		bdl	bdl	bdl	4.50		bdl		0.03	0.15	0.08	0.14
YC5A	11/15/93	0.02	0.02			bdl	bdl	0.08		0.06		bdl	bdl	bdl	3.70		bdl		0.03	0.40	0.07	0.31
YC5A	11/29/93	0.01	0.02			bdl	0.01	0.03		0.06		bdl	bdl	bdl			bdl		bdl	0.20	0.07	0.04
YC5As	12/5/93	0.03	bdl	0.02	bdl	bdl	bdl	0.11	0.93	0.08	bdl	bdl	bdl	bdl			bdl	0.01	bdl	0.41	0.11	0.33
YC5A	12/13/93	0.05	bdl	bdl	bdl	bdl	bdl	0.17	bdl	0.06	bdl	bdl	bdl	bdl			bdl	bdl	0.02	0.37	0.07	0.15

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Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
YC12	1/11/93	1140	8.3	6.9	9.1	6	15.00	76	490	3.20	26	35	15		17.0	<0.1	
YC12	1/25/93	1330	7.4	7.7	9.8	9	33.80	68	417	10.40	25	33	15		10.0	<0.1	
YC12	2/8/93	1430	8.2	7.1	10.4	3	3.10	116	433	3.20	46	65	15		21.0	<0.1	
YC12	2/22/93	1230	7.4	7.3	9.8	7	45.00	69	471	10.20	32	44	10		11.0	<0.1	
YC12	3/8/93	1450	9.1	7.0	93.0	4	19.30	79	460	2.70	32	47	10		14.0		
YC12	3/22/93	1335	9.1	6.8	9.6	8	39.00	57	487	8.60	21	38	15		7.8		
YC12s	3/23/93	1400	7.9	7.9	9.2	200		53	449	230.00	19	33	35		13.0	bdl	7.70
YC12	4/2/93	1135	9.4	7.1	8.7	9	21.70	92	357	9.80	32	48	10		12.0	bdl	
YC12	4/19/93	1245	15.7	6.9	7.7	6	9.00	77	463	0.40	32	52	5		13.0	bdl	
YC12	5/3/93	1501	16.4	7.2	7.5	2	7.80	78	436	1.50	35	46	10		19.0	bdl	
YC12	5/17/93	1130	17.8	7.2	6.7	5	2.30	115	463	5.60	52	71	25		46.0	bdl	
YC12	5/31/93	1050	19.1	7.4	6.3	7	2.00	169	372	7.10	56	78	15		48.0		
YC12	6/14/93	1055	20.4	7.3	6.2	7	1.00	173	389	6.90	65	90	15	bdl	51.0	bdl	
YC12	7/6/93	1505	28.9	8.0	5.6	6	0.58	7	431	5.30	76	109	10		54.0	bdl	
YC12	7/19/93	1130	24.6	7.5	6.5	14	0.60	279	350	13.90	110	162	15		57.0	bdl	
YC12	8/9/93	1450	24.6	7.3	8.0	6	0.71	470	387	8.40	200	308	10	bdl	28.0	bdl	
YC12	8/23/93	1550	26.3	7.4	8.1	4	0.64	369	467	3.50	160	222	25		38.0	bdl	
YC12	9/7/93	1445	24.3	7.4	7.9	5		232	468	29.20	92	121	20		58.0	bdl	
YC12	9/21/93	1018	18.7	7.4	6.4	6	0.65	216	428	4.80	100	122	20		60.0	bdl	

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Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
YC12	1/11/93	6.75	2.30	1.30	1.00	0.62	11.00	0.39	<0.02	1.70	10.37		0.62	1.01	<0.1	<0.1	<0.3	
YC12	1/25/93	6.78	1.90	1.30	1.00		14.00	1.54	<0.02	1.10	6.10			0.94	<0.1	<0.1	<0.3	
YC12	2/8/93	14.29	2.40	1.90	1.70		29.00	1.21	<0.02	1.60	12.81			1.04	<0.1	<0.1	<0.3	
YC12	2/22/93	9.27	2.10	1.20	1.10	0.72	22.00	0.38	<0.02	1.30	6.71		0.72	1.01	<0.1	<0.1	<0.3	
YC12	3/8/93	9.32	2.10	2.00	1.30	0.76	21.00	0.56		2.30	8.54		0.79	1.04				
YC12	3/22/93	5.33	1.90	0.01	0.90	0.50	22.00	bdl	0.75	1.00	13.42		0.65	1.30	bdl	bdl	bdl	
YC12s	3/23/93	5.20	1.50	1.00	1.30	0.48	14.00	0.53	bdl	1.40	7.93		0.60	1.24	bdl	bdl	bdl	
YC12	4/2/93	9.56	2.10	1.60	1.60	0.77	23.00	0.59	bdl	2.00	7.32		0.79	1.03	bdl	bdl	bdl	
YC12	4/19/93	9.35	2.20	1.40	1.20	0.75	28.00	0.50	bdl	1.70	7.93		0.89	1.20	bdl	bdl	bdl	
YC12	5/3/93	10.20	2.30	1.50	1.30	0.80	18.00	bdl	bdl	1.20	11.59		0.79	0.99	bdl	bdl	bdl	
YC12	5/17/93	16.80	2.50	2.80	3.20	1.26	15.00	0.56	bdl	2.00	28.06		1.30	1.03	bdl	bdl	bdl	
YC12	5/31/93	18.50	2.40	3.70	4.20	1.41	17.00	0.58		2.60	29.28		1.40	0.99				
YC12	6/14/93	22.10	2.30	4.10	4.80	1.61	22.00	0.97	bdl	2.40	31.11		1.56	0.97	bdl	bdl	bdl	
YC12	7/6/93	25.90	2.80	4.40	5.20	1.87	36.00	0.21	bdl	2.10	32.94		1.89	1.02	bdl	bdl	bdl	
YC12	7/19/93	39.70	3.00	5.20	5.50	2.60	70.00	0.85	bdl	3.30	34.77		2.71	1.04	bdl	bdl	bdl	
YC12	8/9/93	76.00	2.70	12.00	7.10	4.72	190.00	0.77	bdl	2.50	17.08		4.61	0.98	0.20	bdl	bdl	
YC12	8/23/93	57.90	3.10	7.20	7.20	3.65	120.00	0.53	bdl	2.90	23.18		3.37	0.92	0.30	bdl	bdl	
YC12	9/7/93	31.50	3.20	6.50	5.90	2.28	36.00	0.89	bdl	1.70	35.38		1.98	0.87	0.20	bdl	bdl	
YC12	9/21/93	34.70	3.30	4.10	4.50	2.30	36.00	0.44	bdl	2.10	36.60		2.03	0.88	0.30	bdl	bdl	

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Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
YC12	1/11/93	0.02	<0.01			<0.01	<0.01	0.17		0.05		<0.01	<0.1	<0.1	2.80		<0.01		<0.01	0.32	0.06	0.04
YC12	1/25/93	<0.01	<0.01			<0.01	<0.01	0.06		0.03		<0.01	<0.1	<0.1	2.70		<0.01		<0.01	0.26	0.04	0.14
YC12	2/8/93	<0.01	<0.01			<0.01	<0.01	0.19		0.08		<0.01	<0.1	<0.1	3.10		<0.01		<0.01	0.45	0.08	0.08
YC12	2/22/93	<0.01	<0.01			<0.01	<0.01	0.06		0.02		<0.01	<0.1	<0.1	2.60		<0.01		<0.01	0.29	0.02	0.13
YC12	3/8/93	0.01						0.12		0.04		0.02			2.50		bdl			0.25	0.04	0.05
YC12	3/22/93		bdl			bdl	bdl	0.03		0.02		bdl	bdl	bdl	2.50		bdl		0.01	0.16	0.02	0.01
YC12s	3/23/93	0.16	bdl	0.01		bdl	bdl	0.14		0.05		bdl	bdl	bdl	2.30	0.01	bdl	bdl	0.01	1.70	0.25	0.78
YC12	4/2/93	0.02	bdl			bdl	bdl	0.11		0.05		bdl	bdl	bdl	2.60		bdl		0.01	0.17	0.05	0.05
YC12	4/19/93	0.02	bdl			bdl	bdl	0.12		0.05		bdl	bdl	bdl	2.50		bdl		0.01	0.37	0.05	1.00
YC12	5/3/93	bdl	bdl			bdl	bdl	0.12		0.05		bdl	bdl	bdl	2.50		bdl		0.01	0.28	0.05	0.08
YC12	5/17/93	0.04	bdl			bdl	bdl	0.18		0.11		bdl	bdl	bdl	3.50		bdl		0.02	0.62	0.11	0.04
YC12	5/31/93	0.10	0.01					0.23		0.10					3.70		bdl		0.04	0.72	0.11	0.28
YC12	6/14/93	0.07	0.01			bdl	bdl	0.18		0.08		bdl	bdl	bdl	4.10		bdl		bdl	0.67	0.09	0.17
YC12	7/6/93	0.09	bdl			bdl	bdl	0.25		0.10		bdl	bdl	bdl	4.30		bdl		bdl	0.58	0.10	0.15
YC12	7/19/93	0.02	0.01			bdl	bdl	0.20		0.14		bdl	bdl	bdl	4.10		bdl		0.02	0.62	0.14	0.20
YC12	8/9/93	0.02	0.02			bdl	bdl	0.15		0.17		bdl	bdl	bdl	5.40		bdl		0.03	0.67	0.17	0.18
YC12	8/23/93	0.01	0.02			bdl	bdl	0.18		0.16		0.02	bdl	bdl	5.40		bdl		0.01	0.65	0.16	0.10
YC12	9/7/93	0.03	0.02			bdl	0.01	0.35		0.11		bdl	bdl	bdl	4.50		bdl		bdl	0.66	0.12	0.12
YC12	9/21/93	bdl	0.02			bdl	bdl	0.24		0.11		bdl	bdl	bdl	4.50		bdl		0.01	0.67	0.12	0.06

Station 988 Water Quality Data 1993

Site	Date	TIME	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
988	1/11/93	1525	10.0	7.5	8.5	47	0.30	643	524	33.30	210	382	30		140.0	<0.1	
988	2/22/93	1150	8.4	7.5	8.2	4	0.13	625	428	6.40	230	396	10		120.0	<0.1	
988	3/22/93	1405	10.7	7.0	7.9	3	9.00	101	451	5.70	260	597	15		140.0	bdl	
988s	3/23/93	1420	9.2	7.4	9.1	200	10.25	285	422	215.00	87	210	30		53.0	bdl	20.00
988s	12/5/93	1006	10.9	7.4	9.3	bdl	0.92	551	495	10.50	210	296	20		93.0	bdl	3.80

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	BR	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
988	1/11/93	76.71	5.5	54	4.6	6.75	85	29.96	<0.02	42	85.4		6.24	0.93	<0.1	<0.1	<0.3	
988	2/22/93	80.72	6	63	4.6	7.37	88	28.01	<0.02	54	73.2		6.21	0.84	<0.1	<0.1	<0.3	
988	3/22/93	91.7	6.5	10	4.6	9.56	120	55	bdl	14	85.4		1	1.05	bdl	bdl	bdl	
988s	3/23/93	30	3	19	3	2.68	68	21	bdl	34	32.33		3.77	1.41	bdl	bdl	bdl	
988s	12/5/93	76	6.1	3	4.6	4.54	110	13	bdl	27	56.73		5.14		0.4	bdl	bdl	bdl

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
988	1/11/93	0.08	0.02			<0.01	<0.01	0.09		0.02		<0.01	<0.1	<0.1	2.40		<0.01		<0.01	0.76	0.06	0.21
988	2/22/93	<0.01	0.02			<0.01	<0.01	0.03		0.03		<0.01	<0.1	<0.1	2.30		<0.01		<0.01	0.13	0.03	0.07
988	3/22/93	bdl	0.01			bdl	bdl	bdl		0.02		0.02	bdl	bdl	2.50		bdl		0.01	0.06	0.03	0.01
988s	3/23/93	0.26	0.01	0.02		bdl	0.02	0.17		0.02		bdl	bdl	bdl	2.10	0.14	bdl	bdl	0.02	1.10	0.11	0.81
988s	12/5/93	0.06	0.02	0.04	bdl	bdl	bdl	0.07	1.13	0.02	bdl	bdl	bdl	bdl			bdl	0.01	bdl	0.15	0.02	0.16

Miscellaneous Stations Water Quality Data 1993

Site	Date	Time	Temperature	pH	Dissolved Oxygen	Turbidity	Flow Rate	Specific Conductance	EH	Total Suspended Sediment	Hardness	Total Dissolved Solids	Color	Oil & Grease	Alkalinity	Acidity	Total Organic Carbon
			deg C		ppm	ntu	cfs	uS		ppm	ppm	ppm	Pt-Co	ppm	ppm CaCO3	ppm CaCO3	ppm
IFs	3/23/93	1430	11.9	7.7	6.4	200		132	418	151	62	79	35		54	bdl	8.3
KY18s	3/23/93	1235	10.1	7.6	8.3	200	4.7	118	468	527	56	bdl	40		140	bdl	16
CUDJO	6/26/93	1135	12.6	6.6	5.9	bdl		167	466	bdl	82	86	10		74	bdl	
DR9	8/23/93	1500	22.2	7.7	5.4	3	0.01	127	459	7.8	58	64	25		51	bdl	

Site	Date	Ca	Mg	Na	K	Major Cations	SO4	NO3	NO2	Cl	HCO3	CO3	Major Anions	Anions/ Cations	F	Br	PO4	As
		ppm	ppm	ppm	ppm	meq	ppm	ppm	ppm	ppm	ppm	ppm	meq	ratio	ppm	ppm	ppm	ppm
IFs	3/23/93	22.00	1.90	0.93	1.70	1.39	14.00	2.90	bdl	2.10	32.94		1.00	1.06	bdl	bdl	bdl	
KY18s	3/23/93	20.00	1.40	0.46	1.60	1.23	9.00	0.88	bdl	0.90	85.40		3.03		bdl	bdl	bdl	
CUDJO	6/26/93	27.20	3.50	1.00	0.80	1.70	7.10	0.83	0.43	0.90	45.14		1.68	0.98	bdl	bdl	bdl	
DR9	8/23/93	18.40	2.90	2.20	1.70	1.30	4.40	0.67	bdl	2.90	31.11		1.22	0.93	0.20	bdl	bdl	

Site	Date	Al	B	Ba	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	P	Pb	Si	Sr	Ti	V	Zn	Total Fe	Total Mn	Total Al
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
IFs	3/23/93	0.45	bdl	0.01		bdl	bdl	0.12		bdl		bdl	bdl	bdl	2.60	0.06	bdl	bdl	0.02	0.40	0.11	0.53
KY18s	3/23/93	0.46	bdl	0.02		bdl	bdl	0.27		0.02		bdl	bdl	bdl	2.00	0.04	bdl	bdl	0.02	2.10	0.17	0.93
CUDJO	6/26/93	bdl	bdl			bdl	bdl	bdl		bdl		bdl	bdl	bdl	3.20		bdl		bdl	bdl	bdl	bdl
DR9	8/23/93	0.02	bdl			bdl	bdl	0.18		0.02		bdl	bdl	bdl	3.50		bdl		bdl	0.31	0.03	0.08

Appendix C

1993 Sediment Chemistry Data

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Station DB5 Sediment ChemistryData 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DB5	1/26/93	4.60	0.015	5.50	bdl	bdl	bdl	bdl	bdl	bdl		bdl	bdl	0.10	1.0	0.21	bdl	12.0	0.02	12.0	0.83	7.8	bdl
DB5	6/1/93	5.30	bdl	27.00	bdl	bdl	bdl	bdl	bdl	bdl	12.2	1.0	bdl	3.00	61.0	bdl	4.0	bdl	1.85	49.5	37.00	25.0	0.74
DB5	10/19/93	5.30		27.00			bdl				24.2	0.2		1.28	42.0	4.17	4.4	290.0	2.57	102.0	110.00	13.0	0.57

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
DB5	1/26/93	0.20	0.41	5	2.50	bdl	0.10	bdl	38.0	bdl	20.0	bdl	bdl	71.0	11.10	bdl	11.50	0.50	14.0	12.0
DB5	6/1/93	183.00	2.20	139	19.00	bdl	bdl	1.6	26.0	3.4	2.7	bdl	bdl	97.0	52.00	bdl	4.40	0.40	bdl	4.0
DB5	10/19/93	14.00	0.61	503	52.00	0.8		1.4	3.7	bdl	0.2	bdl		4.6	4.30		5.60	2.00	2.7	3.6

Station DB10 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DB10	1/26/93	6.50	0.023	3.20	bdl	bdl	bdl	bdl	bdl	bdl		bdl	bdl	bdl	1.3	0.13	bdl	7.2	0.17	7.3	1.80	8.1	bdl
DB10	6/1/93	7.60	bdl	7.80	bdl	bdl	bdl	bdl	bdl	bdl	17.7	5.5	bdl	2.83	190.0	9.60	6.9	bdl	2.17	137.0	280.0	27.0	1.60
DB10	10/19/93	7.50		15.00			bdl				12.0	0.6		0.91	77.0	5.31	6.4	199.0	1.49	88.6	290.0	27.0	0.58

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
DB10	1/26/93	7.00	0.34	12	2.70	bdl	bdl	bdl	32.0	bdl	18.0	bdl	bdl	73.0	94.00	bdl	25.30	0.70	8.0	26.0
DB10	6/1/93	296.00	2.20	4020	32.00	0.6	bdl	12.0	26.0	3.6	2.7	bdl	bdl	49.0	47.00	bdl	19.00	bdl	86.1	19.0
DB10	10/19/93	10.70	0.82	5400	32.00	0.6		11.0	3.7	bdl	0.2	bdl		6.3	2.80		59.00	1.30	1.3	57.7

Station GC3 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
GC3	1/26/93	7.40	0.096	3.70	bdl	bdl	bdl	bdl	bdl	bdl		0.6	bdl	0.14	2.9	0.29	bdl	7.3	0.16	7.3	8.20	7.4	bdl
GC3	6/1/93	7.70	bdl	16.00	bdl	0.30	bdl	bdl	bdl	bdl	29.8	18.0	bdl	2.13	570.0	19.90	22.0	bdl	2.76	195.0	850.00	30.0	2.00
GC3	7/6/93	7.90	522.000	3.40	bdl	0.14	bdl	bdl	bdl	bdl	9.4	9.0	bdl	0.27	150.0	10.20	26.0	544.0	bdl	165.0	46.00	35.0	0.30

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
GC3	1/26/93	2.30	0.29	460	2.30	bdl	bdl	bdl	37.0	bdl	20.0	bdl	bdl	190.0	11.00	bdl	297.00	3.00	6.0	300.0
GC3	6/1/93	494.00	3.20	12600	100.00	bdl	bdl	8.9	23.0	3.1	2.9	bdl	bdl	59.0	48.00	bdl	170.00	5.90	87.2	164.0
GC3	7/6/93	9.20	0.99	19400	51.00	bdl	bdl	4.7	35.0	bdl	bdl	bdl	bdl	83.0	1.70	bdl	37.00	1.60	bdl	35.4

Station GC7 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
GC7	1/26/93	6.90	0.050	4.20	bdl	bdl	bdl	bdl	bdl	bdl		0.1	bdl	0.19	3.9	0.24	1.1	24.0	0.20	24.0	9.30	6.5	bdl
GC7	6/1/93	7.60	bdl	20.00	bdl	0.20	bdl	bdl	bdl	bdl	18.5	6.6	bdl	3.31	230.0	15.00	30.0	0.9	3.09	160.0	440.00	29.0	2.00
GC7	7/6/93	7.10	885.000	8.10	bdl	0.14	bdl	bdl	bdl	bdl	21.2	18.0	bdl	0.94	170.0	12.80	14.0	bdl	1.99	90.1	46.00	51.0	0.95
GC7	10/19/93	7.00		11.00			bdl				20.5	1.0		1.88	89.0	18.20	50.0	373.0	3.07	232.0	430.00	34.0	0.97

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
GC7	1/26/93	4.60	0.14	59	1.50	bdl	bdl	bdl	36.0	bdl	55.0	bdl	bdl	130.0	67.00	bdl	178.00	1.60	17.0	180.0
GC7	6/1/93	325.00	3.00	3170	41.00	bdl	bdl	10.0	41.0	3.8	2.3	bdl	bdl	42.0	58.00	bdl	26.00	0.60	47.9	25.0
GC7	7/6/93	142.00	1.30	8900	120.00	0.8	bdl	5.2	8.0	bdl	bdl	bdl	bdl	bdl	1.70	bdl	14.00	2.80	11.5	11.2
GC7	10/19/93	14.20	1.20	6900	59.00	0.4	0.09	7.3	3.3	bdl	0.2	bdl		13.0	3.20		110.00	1.80	1.8	108.0

Station LH5 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
LH5	1/26/93	6.20	0.012	5.80	bdl	bdl	bdl	bdl	bdl	bdl	0.1	bdl	bdl	bdl	2.2	bdl	bdl	6.2	0.11	6.2	1.50	6.6	bdl
LH5	6/1/93	7.20	bdl	24.00	bdl	0.19	bdl	bdl	bdl	bdl	55.5	bdl	bdl	2.60	300.0	9.99	5.8	bdl	2.04	281.0	150.00	22.0	3.70
LH5	7/6/93	7.50	160.000	11.00	bdl	0.14	bdl	bdl	bdl	bdl	37.7	2.8	bdl	0.71	120.0	3.90	37.0	364.0	1.19	128.0	70.00	36.0	1.60

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
LH5	1/26/93	4.10	0.10	12	1.00	bdl	bdl	bdl	44.0	bdl	21.0	bdl	bdl	58.0	57.00	bdl	10.60	0.40	14.0	11.0
LH5	6/1/93	512.00	3.80	1140	81.00	bdl	bdl	3.7	17.0	3.3	2.0	bdl	bdl	30.0	52.00	bdl	1.40	0.50	57.3	0.9
LH5	7/6/93	159.00	1.00	1010	30.00	1.2	bdl	2.8	7.2	bdl	bdl	bdl	bdl	84.0	bdl	bdl	8.30	0.50	bdl	7.8

Station ST10 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	LI	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
ST10	1/26/93	6.4	0.0	9.9	bdl	bdl	bdl	bdl	bdl	bdl		bdl	bdl	bdl	2.0	0.1	bdl	7.0	0.2	6.7	0.8	6.2	bdl
ST10	6/1/93	7.0	bdl	24.0	bdl	0.1	bdl	bdl	bdl	bdl	28.8	2.5	bdl	3.4	250.0	8.5	32.0	bdl	1.9	289.0	84.0	30.0	3.0
ST10	7/6/93	7.4	272.0	15.0	bdl	bdl	bdl	bdl	bdl	bdl	16.4	0.9	bdl	0.7	110.0	4.6	5.0	111.0	0.8	124.0	460.0	55.0	0.9
ST10	10/19/93	7.2		23.0			bdl				25.7	0.4		0.9	80.0	5.3	48.0	200.0	1.1	188.0	85.0	14.0	0.9

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
ST10	1/26/93	3.1	bdl	9.0	bdl	bdl	bdl	bdl	35.0	bdl	20.0	bdl	bdl	57.0	75.0	bdl	9.7	0.3	9.0	10.0
ST10	6/1/93	480.0	3.4	970.0	43.0	bdl	0.2	4.4	23.0	bdl	3.9	bdl	bdl	24.0	56.0	bdl	5.1	0.3	71.8	4.8
ST10	7/6/93	173.0	1.0	15500.0	38.0	2.2	bdl	5.6	20.0	bdl	bdl	bdl	bdl	80.0	bdl	bdl	26.0	0.9	bdl	25.1
ST10	10/19/93	19.8	2.3	1640.0	38.0	0.1	0.1	bdl	3.2	bdl	0.2	bdl		12.0	3.3		100.0	1.2	2.0	98.8

Station TC10 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TC10	1/26/93	7.90	0.04	4.90	bdl	bdl	bdl	bdl	bdl	bdl		0.1	bdl	0.12	12.0	0.16	bdl	14.0	0.23	14.0	6.50	6.4	bdl
TC10	6/1/93	8.60	0.34	4.60	bdl	bdl	bdl	bdl	bdl	bdl	5.2	22.0	bdl	2.18	300.0	bdl	bdl	7.0	bdl	3.8	440.0	26.0	bdl
TC10	7/6/93	8.00	1930.00	11.00	bdl	bdl	bdl	bdl	bdl	bdl	17.4	21.0	bdl	1.84	57.0	17.70	bdl	398.0	2.45	42.0	320.0	32.0	0.72
TC10	10/19/93	7.00		37.00			bdl				13.6	0.7	1.40	2.20	200.0	8.06	21.0	525.0	2.71	58.3	170.0	51.0	0.51

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE			
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm				
TC10	1/26/93	11.60	0.61	71	3.30	bdl	bdl	bdl	61.0	bdl	30.0	bdl	bdl	130.0	72.00	bdl	149.00	1.30	9.0	150.0			
TC10	6/1/93	66.20	0.40	19200	110.00	bdl	0.13	bdl	26.0	4.6	bdl	bdl	bdl	1100.0	50.00	bdl	90.00	11.00	55.2	79.0			
TC10	7/6/93	589.00	0.34	9820	34.00	4.0	6.31	bdl	23.0	bdl	bdl	bdl	bdl	170.0	1.80	bdl	140.00	6.00	bdl	134.0			
TC10	10/19/93	38.20	0.43	3080	110.00	2.0	3.65		0.6	bdl	0.4	0.5		3.2	3.60		32.00	1.50	0.2	30.5			

Station TD1 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
TD1	1/26/93	6.80	0.140	11.00	bdl	bdl	bdl	bdl	bdl	bdl	0.1	0.2	bdl	0.25	7.2	0.47	2.0	63.0	0.26	63.0	8.60	7.7	bdl
TD1	6/1/93	7.30	bdl	2.10	bdl	0.81	bdl	bdl	bdl	bdl	46.2	22.0	bdl	2.16	150.0	27.30	2.3	bdl	2.25	222.0	920.00	30.0	2.20
TD1	7/6/93	4.80	154.000	2.90	bdl	0.95	bdl	bdl	bdl	bdl	94.8	1.4	bdl	1.53	41.0	23.30	4.1	220.0	16.00	47.6	160.00	29.0	1.00
TD1	10/19/93	6.90	0.140	5.00		0.71	bdl				48.5	2.8		2.43	120.0	32.30	3.3	483.0	6.00	361.0	4900.00	42.0	1.40

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
TD1	1/26/93	9.10	0.26	130	2.40	bdl	bdl	bdl	36.0	bdl	20.0	7.0	bdl	310.0	14.00	bdl	26.60	4.40	64.0	31.0
TD1	6/1/93	167.00	3.10	16800	66.00	0.5	bdl	bdl	30.0	5.0	3.6	bdl	bdl	230.0	80.00	bdl	24.00	2.90	90.4	21.0
TD1	7/6/93	405.00	0.73	13600	29.00	0.2	1.50	1.4	18.0	bdl	bdl	bdl	bdl	120.0	1.80	bdl	4.60	0.50	bdl	4.1
TD1	10/19/93	18.70	3.00	17900	83.00		0.13		4.1	bdl	0.2	bdl		23.0	6.20		74.00	4.30	6.2	69.8

Station YC5 Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
YC5	1/26/93	6.00	0.008	24.00	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	0.11	bdl	0.14	bdl	2.3	0.11	2.4	0.59	5.8	bdl
YC5	6/1/93	6.40	bdl	9.20	bdl	bdl	bdl	bdl	bdl	bdl	4.4	0.9	bdl	1.97	130.0	2.99	9.8	12.0	1.31	83.3	20.00	22.0	0.24
YC5	7/6/93	8.00	232.000	24.00	bdl	bdl	bdl	bdl	bdl	bdl	9.9	3.1	bdl	0.52	340.0	2.12	8.3	1.3	1.32	48.3	64.00	29.0	0.20
YC5	10/19/93	5.70		11.00			bdl				9.4	0.2		1.01	430.0	2.16	9.1	176.0	1.06	22.2	60.00	14.0	0.16

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
YC5	1/26/93	0.60	bdl	3	2.80	bdl	bdl	bdl	630.0	bdl	20.0	bdl	bdl	51.0	40.00	bdl	1.15	0.30	4.0	1.4
YC5	6/1/93	166.00	0.50	230	18.00	1.6	bdl	4.3	24.0	7.3	1.7	bdl	bdl	29.0	51.00	bdl	4.20	0.20	1.7	4.0
YC5	7/6/93	160.00	0.67	321	25.00	2.8	0.10	10.0	20.0	bdl	bdl	bdl	bdl	94.0	3.70	bdl	12.00	0.70	bdl	11.3
YC5	10/19/93	25.60	0.18	946	55.00	5.6	0.05	1.0	2.7	bdl	0.1	bdl		3.1	2.10		3.70	2.60	1.0	1.1

Station YC5A Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
YC5A	1/26/93	7.80	0.039	7.50	bdl	bdl	bdl	bdl	bdl	bdl		bdl	bdl	0.02	bdl	0.20	bdl	11.0	0.41	12.0	4.00	6.5	bdl
YC5A	6/1/93	8.00	bdl	5.60	bdl	bdl	bdl	bdl	bdl	bdl	8.9	1.5	bdl	2.00	150.0	6.80	14.0	3.0	1.91	16.4	60.00	13.0	0.96
YC5A	7/6/93	8.20	400.000	14.00	bdl	bdl	bdl	bdl	bdl	bdl	8.2	10.0	bdl	1.40	580.0	8.60	11.0	123.0	1.88	119.0	270.00	39.0	0.51
YC5A	10/19/93	7.50		18.00			bdl				11.2	0.8	2.20	3.60	830.0	39.80	23.0	878.0	5.82	104.0	210.00	bdl	1.30

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
YC5A	1/26/93	7.80	bdl	37	2.90	bdl	bdl	bdl	51.0	bdl	19.0	bdl	bdl	70.0	75.00	bdl	29.00	1.20	9.0	29.0
YC5A	6/1/93	247.00	1.80	659	26.00	0.6	0.80	5.2	38.0	16.0	3.1	bdl	bdl	40.0	45.00	bdl	8.40	0.10	1.9	8.3
YC5A	7/6/93	299.00	0.85	2670	54.00	3.4	5.20	2.8	10.0	bdl	bdl	bdl	bdl	130.0	1.50	bdl	4.70	1.30	bdl	3.4
YC5A	10/19/93	86.20	1.20	4760	110.00	6.5	11.00	2.7	2.0	bdl	0.2	bdl		32.0	5.30		23.00	2.60	1.6	20.4

Miscellaneous Stations Sediment Chemistry Data 1993

Site	Date	Paste pH	Total S	Total C	Ge	Cd	As	Hg	Mo	Li	Ba	Sr	V	B	Si	Zn	P	Fe	Cu	Mn	Mg	Na	Co
			ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DG3	7/6/93	6.50	172.000	14.00	bdl	bdl	bdl	bdl	bdl	bdl	17.0	2.5	bdl	1.22	73.0	1.98	6.0	341.0	1.52	160.0	91.00	31.0	0.57
SR10	7/6/93	5.90	bdl	17.00	bdl	bdl	bdl	bdl	bdl	bdl	21.2	1.0	bdl	0.94	130.0	6.37	bdl	172.0	1.28	23.6	32.00	27.0	0.85

Site	Date	Al	Ni	Ca	K	Ti	Cr	Pb	Cl	NO2	NO3	Br	PO4	SO4	TOC	Oil & Grease	NEU_POT	POT_ACID	F	ACIDBASE
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
DG3	7/6/93	122.00	1.30	225	53.00	1.3	bdl	1.8	11.0	bdl	bdl	bdl	bdl	77.0	1.50	bdl	16.00	0.50	bdl	14.2
SR10	7/6/93	152.00	0.49	7820	32.00	0.6	bdl	1.3	7.5	bdl	bdl	bdl	bdl	73.0	bdl	bdl	2.00	0.30	bdl	1.7

Appendix D

Summary of Benthic Macroinvertebrate Samples
June 1990 to May 1993

All data in this appendix are from Skelton and Eisenhour (1993)

Appendix D Index

Station .... Page

1. DB5 .... D-2
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4. DB8 .... D-2
5. DB10 .... D-2
6. GC3 .... D-3
7. GC7 .... D-3
8. LH5 .... D-4
9. LH10 .... D-4
10. MF2 .... D-5
11. MF5 .... D-5
12. ST5 .... D-6
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14. TC7 .... D-7
15. TC10 .... D-7
16. YC1 .... D-8
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18. YC5A D-8
19. YC6 .... D-8
20. YC12 .... D-8
21. DR9 .... D-9
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Davis Branch - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
DB5	Total specimens	105	257	83	394	82	29	53	70	84	46	48	110
	Taxa richness	19	26	26	29	21	12	20	18	12	5	15	25
	% EPT taxa	43	46	54	55	24	26	35	50	25	40	60	52
	Diversity index	1.12	1.17	1.2	1.15	1.14	0.91	1.17	1.08	0.82	0.4	1.01	0.95
DB6	Total specimens	70	335	123	161	57	85						
	Taxa richness	23	26	18	22	17	21						
	% EPT taxa	39	38	56	59	41	38						
	Diversity index	1.19	0.99	1.01	1.14	1.06	1.21						
DB7	Total specimens	74	204	119	247	24	65						
	Taxa richness	21	25	19	31	12	16						
	% EPT taxa	57	48	68	48	33	50						
	Diversity index	1.04	1.04	1.08	1.04	0.99	1.02						
DB8	Total specimens	96	324	106	343	79	122						
	Taxa richness	25	29	17	31	21	22						
	% EPT taxa	44	52	59	52	33	59						
	Diversity index	1.23	1.04	1.18	1.12	1.17	0.94						
DB10	Total specimens	203	504	196	207	84	428	106	119	103	54	54	91
	Taxa richness	29	20	25	28	14	26	23	15	19	2	12	25
	% EPT taxa	59	40	56	61	29	42	57	47	21	33	50	60
	Diversity index	1.12	0.79	1.09	1.22	0.9	0.73	1.07	0.87	0.99	0.58	0.89	1.22

Gap Creek - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
GC3	Total specimens	264	425	625	722	322	263	814	180	312	193	246	245
	Taxa richness	14	21	13	15	19	16	27	10	14	9	19	17
	% EPT taxa	50	43	54	40	37	63	59	30	50	11	42	65
	Diversity index	0.64	0.84	0.57	0.39	0.71	0.76	0.77	0.77	0.81	0.83	0.9	0.82
GC7	Total specimens	1053	1431	495	688	6655	1071	818	411	303	121	192	175
	Taxa richness	15	22	21	23	23	21	29	13	15	6	15	19
	% EPT taxa	40	45	52	61	30	38	45	38	33	0	60	63
	Diversity index	0.74	0.69	0.64	0.62	1.01	0.92	0.92	0.78	0.83	0.66	0.73	0.84

Lewis Hollow - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
LH5	Total specimens									154	86	182	125
	Taxa richness									8	2	10	9
	% EPT taxa									38	50	60	0.89
	Diversity index									0.44	0.093	0.61	0.73
LH10	Total specimens							452	58				
	Taxa richness							17	5				
	% EPT taxa							65	60				
	Diversity index							0.29	0.32				

Martins Fork - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
MF2	Total specimens					134				84		90	
	Taxa richness					15				15		17	
	% EPT taxa					67				53		71	
	Diversity index					0.78				0.67		0.98	
MF5	Total specimens					92				53		97	
	Taxa richness					16				10		15	
	% EPT taxa					50				40		73	
	Diversity index					0.86				0.8		0.93	

Station Creek - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
ST5	Total specimens							664	70	118	102	104	169
	Taxa richness							32	8	23	9	18	27
	% EPT taxa							66	38	48	33	61	37
	Diversity index							0.78	0.74	1.08	0.79	0.85	1.09
ST10	Total specimens							559	65	122	103	83	72
	Taxa richness							28	9	19	9	21	17
	% EPT taxa							68	56	37	11	66	71
	Diversity index							0.98	0.84	0.93	0.77	1.09	0.96

Tunnel Creek - Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
TC7	Total specimens	95	115	108									
	Taxa richness	4	8	9									
	% EPT taxa	50	38	67									
	Diversity index	0.32	0.52	0.48									
TC10	Total specimens	38	86	48	63	52	3	1	4		1	1	1
	Taxa richness	4	11	8	10	8	1	1	3		1	1	1
	% EPT taxa	50	45	50	70	63	0	0	33		0	0	0
	Diversity index	0.4	0.88	0.66	0.68	0.64	0	0	0.45		0	0	0

Little Yellow Creek-Summary of Benthic Macroinvertebrate Data 1990-1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
YC1	Total specimens	67	278	54	60	128	866	160	30	138	95	24	76
	Taxa richness	13	16	13	19	21	20	21	5	21	11	13	17
	% EPT taxa	38	56	69	63	29	40	52	20	38	36	62	65
	Diversity index	1.08	0.62	0.85	1.14	1	1	0.57	1.06	0.57	0.98	0.83	1.06
YC5	Total specimens	313	633	147	112	34	7	47	21	36	44	34	26
	Taxa richness	15	14	20	16	9	4	10	8	17	7	9	9
	% EPT taxa	47	57	65	56	33	50	70	38	12	14	33	89
	Diversity index	0.74	0.61	0.92	0.97	0.45	0.56	0.73	0.69	1.15	0.73	0.83	0.82
YC5A	Total specimens	182	211	215	238	102	17	113	21	19		8	57
	Taxa richness	19	16	15	22	16	3	13	6	6		4	13
	% EPT taxa	47	50	73	59	44	67	62	50	0		25	85
	Diversity index	0.84	0.84	0.84	0.93	0.93	0.35	0.79	0.68	0.64		0.53	0.81
YC6	Total specimens	74	66	32	93	68	16	9	11		5		
	Taxa richness	12	13	11	17	12	7	6	4		2		
	% EPT taxa	42	54	73	65	58	43	83	50		0		
	Diversity index	0.69	0.73	1	0.97	0.93	0.68	0.73	0.51		0.29		
YC12	Total specimens	53	184	76	76	47	29	34	40	17	9	3	13
	Taxa richness	8	19	14	22	16	10	10	6	7	4	2	5
	% EPT taxa	38	37	71	55	31	30	30	0	0	0	0	20
	Diversity index	0.69	0.87	0.96	1.13	1.05	0.82	0.75	0.44	0.66	0.55	0.28	0.58

Miscellaneous Stations
Summary of Benthic Macroinvertebrate Data 1990 - 1993
(Skelton and Eisenhour, 1993)

Station		Jun-90	Oct-90	Feb-91	Apr-91	Jul-Aug/91	Oct-91	Jan-Feb/92	May-92	Aug-92	Oct-92	Feb-93	May-93
DR9	Total specimens			163	230	27	103	175	42	33	25	51	70
	Taxa richness			25	28	17	22	32	10	15	10	16	14
	% EPT taxa			52	61	35	41	59	40	13	40	69	64
	Diversity index			1.09	1.18	1.15	1.13	1.19	0.9	1.03	0.78	1.1	0.91
SH10	Total specimens					150				36		72	
	Taxa richness					20				12		11	
	% EPT taxa					60				42		82	
	Diversity index					0.97				0.97		0.69	
SR10	Total specimens	214	267	122	189		73	143					
	Taxa richness	32	24	19	19		20	21					
	% EPT taxa	69	50	74	63		50	67					
	Diversity index	1.29	1.05	1.09	1.01		1.05	1.09					

Appendix E

STORET Database Data

Appendix E

STORET Database Data

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                              ****  STORET SUMMARY SECTION  ****

   FOLLOWING  IS A RETRIEVAL OF DATA FROM THE ENVIRONMENTAL PROTECTION AGENCY'S  STORET SYSTEM,
   A DATABASE  OF  SAMPLING  SITES  AND THEIR ASSOCIATED  QUALITY  DATA.  THE  INFORMATION  WAS
   RETRIEVED  USING  SPECIFIC  STORET INSTRUCTION SETS  IN COMBINATION TO SELECT  ONLY THE DATA
   REQUESTED FOR THIS RETRIEVAL. BRIEF EXPLANATIONS OF THE INSTRUCTION SETS ARE INCLUDED BELOW.
                  QUESTIONS MAY BE DIRECTED TO THE STORET USER ASSISTANCE SECTION AT
                                      (800) 424-9067.

                                       ************


          FOLLOWING IS THE FORMAT FOR THE STATION HEADER INFORMATION WHICH APPEARS
           ON EACH PAGE OF THE RETRIEVAL UNLESS STATION AGGREGATION WAS PERFORMED
      *****************************************************************************
      *                                                                           *
      *                                   STATION NUMBER(S)                       *
      *                                   LATITUDE/LONGITUDE PRECISION CODE       *
      *                                   STATION LOCATION                        *
      *                                   STATE/COUNTY CODE STATE NAME COUNTY NAME *
      *                                   MAJOR BASIN NAME MAJ/MIN/SUB BASIN CODE *
      *                                   MINOR BASIN NAME                        *
      *STATION TYPE                       AGENCY CODE  STORED DATE  HYDROLOGIC UNIT*
      *                                   STATION DEPTH      ELEVATION            *
      *                                   ECOREGION                               *
      *                                   WATER BODY                              *
      *                                   AQUIFERS                                *
      *                                   LOCKED DATE                             *
      *                                                                           *
      *RIVER MILE INDEX                                                           *
      *                                                                           *
      *****************************************************************************


                           CONTINUED ON NEXT PAGE(S)
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                                                                          03401390
                                                                         36 36 22.0 083 41 22.0 2
                                                                         DAVIS B AT MIDDLESBORO
                                                                         21013   KENTUCKY          BELL
                                                                                                   052091
YPA/AMBNT/STREAM
                                                                         112WRD                        05130101
                                                                         0000 FEET DEPTH



            PARAMETER                  MEDIUM         RMK   NUMBER    MEAN   VARIANCE STAN DEV MAXIMUM  MINIMUM   BEG DATE END DATE
00075   TURB     HLGE    PPM SIO2 WATER                          2 6.000000 32.00000 5.656900     10.0      2.0  64/05/27 64/09/22
00080  COLOR     PT-CO    UNITS   WATER                          2 5.000000 .0000000 .0000000        5        5  64/05/27 64/09/22
00095 CNDUCTVY  AT 25C  MICROMHO WATER                           2 270.0000 6050.100 77.78200      325      215  64/05/27 64/09/22
00400     PH               SU     WATER                          2 7.350000 .2450000 .4949700     7.70     7.00  64/05/27 64/09/22
00410  T ALK     CACO3    MG/L    WATER                          2 91.50000 1740.500 41.71900      121       62  64/05/27 64/09/22
00440 HCO3 ION    HCO3    MG/L    WATER                          2 112.0000 2592.000 50.91200      148       76  64/05/27 64/09/22
00900 TOT HARD   CACO3    MG/L    WATER                          2 117.5000 2964.500 54.44700      156       79  64/05/27 64/09/22
00902 NC HARD    CACO3    MG/L    WATER                          2 26.00000 162.0000 12.72800       35       17  64/05/27 64/09/22
00940 CHLORIDE    TOTAL   MG/L    WATER                          2 17.50000 40.50000 6.364000       22       13  64/05/27 64/09/22
00945 SULFATE   SO4-TOT   MG/L    WATER                          2 23.00000 98.00000 9.899500       30       16  64/05/27 64/09/22
01045   IRON    FE,TOT    UG/L    WATER                          2 320.0000 3199.900 56.56800      360      280  64/05/27 64/09/22
01055 MANGNESE     MN     UG/L    WATER                          2 215.0000 42050.00 205.0600    360.0     70.0  64/05/27 64/09/22
38260   MBAS              MG/L    WATER                          1 .0000000                        .00      .00  64/09/22 64/09/22
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                                                          03401380
                                                          36 35 30.0 083 42 15.0 2
                                                          L YELLOW C NR MIDDLESBORO
                                                          21013   KENTUCKY         BELL
                                                                                   052091
YPA/AMBNT/STREAM
                                                          112WRD                      05130101
                                                          0000 FEET DEPTH



         PARAMETER                 MEDIUM          RMK   NUMBER    MEAN   VARIANCE STAN DEV MAXIMUM  MINIMUM   BEG DATE END DATE
0075   TURB     HLGE    PPM SIO2 WATER                       3 2.666700 8.333300 2.886800      6.0      1.0  64/05/27 64/09/18
0080  COLOR     PT-CO    UNITS   WATER                       3 3.666700 1.333300 1.154700        5        3  64/05/27 64/09/18
0095 CNDUCTVY   AT 25C  MICROMHO WATER                       3 30.66700 2.334200 1.527800       32       29  64/05/27 64/09/18
0300    DO                MG/L   WATER                       1 8.000000                        8.0      8.0  64/09/22 64/09/22
0301    DO      SATUR   PERCENT  WATER                       1 91.00000                       91.0     91.0  64/09/22 64/09/22
0400    PH                 SU    WATER                       3 6.533300 .0634230 .2518400     6.80     6.30  64/05/27 64/09/18
0410  T ALK     CACO3     MG/L   WATER                       3 10.00000 19.00000 4.358900       15        7  64/05/27 64/09/18
0440 HCO3 ION   HCO3      MG/L   WATER                       3 12.00000 28.00000 5.291500       18        8  64/05/27 64/09/18
0900 TOT HARD   CACO3     MG/L   WATER                       3 9.666700 .3336200 .5776000       10        9  64/05/27 64/09/18
0902 NC HARD    CACO3     MG/L   WATER                       3 1.333300 1.333300 1.154700        2        0  64/05/27 64/09/18
0940 CHLORIDE   TOTAL     MG/L   WATER                       3 1.666700 .3333400 .5773500        2        1  64/05/27 64/09/18
0945 SULFATE   SO4-TOT    MG/L   WATER                       3 5.133300 2.093300 1.446800        7        4  64/05/27 64/09/18
1045   IRON    FE,TOT     UG/L   WATER                       3 240.0000 3100.000 55.67800      290      180  64/05/27 64/09/18
1055 MANGNESE    MN       UG/L   WATER                       3 583.3300 775830.0 880.8100   1600.0     50.0  64/05/27 64/09/18
8260   MBAS               MG/L   WATER                       2 .0000000 .0000000 .0000000      .00      .00  64/08/26 64/09/18
```

Appendix F

Data for Figures 21 through 32

DB10 Sediment, pH, and Specimen Data

Date	Sediment	pH	Specimens
6/18/90	3.00	7.3	203
7/6/90	3.00	7.1	
7/11/90	10.00	7.3	
7/20/90	2.00	7.4	
8/4/90	2.00	7.3	
8/18/90	3.00	7.3	
9/2/90	4.00	7.3	
9/14/90	0.00	7.3	
9/28/90	45.00	7.2	
10/11/90	4.00	7.6	
10/18/90	17.00	7.2	504
10/25/90	5.00	7.0	
11/8/90	1.00	7.2	
11/23/90	3.00	7.1	
12/9/90	1.00	7.0	
12/21/90	7.00	7.0	
12/24/90	10.00	6.9	
1/3/91	2.00	6.9	
1/17/91	1.00	7.8	
2/3/91	1.00	7.4	
2/14/91	24.00	6.9	196
2/18/91	122.00	6.3	
3/1/91	1.00	7.0	
3/15/91	3.60	6.6	
3/23/91	47.75	6.7	
3/28/91	3.57	7.2	
4/11/91	1.00	7.1	207
4/25/91	2.46	7.0	
5/4/91	1.19	7.1	
5/22/91	9.35	7.1	
6/4/91	6.58	7.2	
6/19/91	3.60	7.0	
7/2/91	1.75	7.0	
7/16/91	1.00	7.1	
7/30/91	4.40	7.2	84
8/12/91	1.00	7.1	
8/28/91	6.67	6.9	
9/10/91	1.66	7.0	
9/22/91	1.00	6.6	
10/6/91	1.00	7.0	
10/19/91	18.45	7.6	426
11/2/91	2.93	7.2	
11/17/91	2.46	7.0	
11/22/91	37.97	7.2	
12/1/91	61.46	7.1	
12/2/91	136.16	6.4	
12/17/91	11.40	6.5	
12/30/91	2.43	6.8	
1/13/92	2.39	6.7	
1/27/92	1.63	6.6	
2/10/92	3.94	7.0	106
2/24/92	1.00	7.3	
3/9/92	2.84	7.1	
3/23/92	2.01	7.0	
4/5/92	1.00	7.4	
4/21/92	82.00	6.7	
5/4/92	1.00	7.7	
5/18/92	1.00	7.9	119
6/1/92	2.00	7.7	
6/15/92	24.00	7.5	
6/29/92	2.78	7.7	
7/13/92	2.10	7.0	
7/27/92	11.30	7.0	
8/10/92	2.80	7.1	103
8/25/92	0.10	7.5	
9/8/92	1.00	7.5	
9/18/92	1.00	7.6	
9/21/92	1.00	7.3	
10/5/92	5.90	7.3	
10/19/92	2.10	7.2	54
11/3/92	0.70	7.5	
11/13/92	1.70	7.0	
12/1/92	0.50	7.4	
12/14/92	0.60	6.8	
12/17/92	58.00	7.7	
1/11/93	1.50	7.0	
1/25/93	6.60	7.7	
2/8/93	0.80	7.2	
2/22/93	10.40	7.4	54
3/8/93	1.80	7.3	
3/22/93	8.80	6.8	
3/23/93	670.00	7.8	
4/2/93	8.30	7.2	
4/19/93	4.70	7.1	
5/3/93	2.40	7.2	
5/17/93	2.50	7.3	91
5/31/93	3.00	7.4	
6/14/93	4.10	6.8	
7/6/93	4.70	8.0	
7/19/93	2.80	7.6	
8/9/93	4.00	7.7	
8/23/93	2.10	7.9	
9/7/93	3.30	7.3	
9/21/93	3.20	7.6	
10/7/93	2.00	7.4	
10/18/93	1.70	7.3	
11/4/93	3.20	7.4	
11/15/93	2.00	7.2	
11/29/93	1.40	7.3	
12/5/93	20.50	7.0	
12/13/93	0.50	7.1	

Sediment values reported as zero or "less than" were set to 1.0.

TC10 Sediment, pH, and Specimen Data

Date	Sediment	pH	Specimens
6/19/90	12.00	7.7	38
7/7/90	7.00	7.5	
7/11/90	6.00	7.9	
7/21/90	5.00	7.7	
8/4/90	7.00	7.8	
8/17/90	6.00	7.8	
9/1/90	5.00	7.7	
9/14/90	3.00	7.8	
9/29/90	1.00	7.6	
10/12/90	5.00	7.6	86
10/18/90	16.00	7.8	
10/24/90	4.00	7.6	
11/8/90	1.00	7.6	
11/24/90	5.00	7.7	
12/8/90	2.00	7.5	
12/20/90	5.00	7.5	
12/24/90	10.00	7.7	
1/4/91	3.00	7.6	
1/20/91	2.00	7.5	
1/31/91	3.00	7.5	
2/14/91	18.00	7.4	48
2/18/91	103.00	7.9	
2/28/91	0.80	7.6	
3/15/91	3.20	7.4	
3/23/91	31.32	7.3	
3/28/91	3.99	7.5	
4/11/91	0.97	7.5	63
4/24/91	8.11	7.8	
5/6/91	13.08	7.5	
5/21/91	20.97	7.5	
6/5/91	8.20	7.3	
6/19/91	15.68	7.6	
7/1/91	14.78	7.7	
7/16/91	62.91	7.5	
7/31/91	310.78	7.6	52
8/13/91	48.79	9.4	
8/28/91	145.57	7.9	
9/3/91	71.44	7.3	
9/10/91	182.51	8.0	
9/18/91	56.22	4.5	
9/24/91	111.86	6.9	
10/8/91	13.10	6.9	
10/16/91	15.26	6.4	3
10/20/91	3.65	8.3	
10/24/91	5.50	4.7	
10/29/91	2.00	9.1	
11/2/91	145.09	7.6	
11/17/91	106.41	6.6	
11/22/91	190.86	9.5	
12/1/91	615.77	7.9	
12/2/91	246.32	9.5	
12/16/91	25.42	7.1	
12/30/91	1.00	7.2	
1/13/92	11.51	7.2	
1/27/92	18.87	6.4	1
2/10/92	12.16	7.9	
2/24/92	16.26	7.1	
3/9/92	13.32	7.7	
3/23/92	33.44	7.3	
4/5/92	8.00	7.4	
4/21/92	19.00	8.1	
5/4/92	8.00	8.0	
5/18/92	6.00	8.0	4
6/1/92	2.00	8.0	
6/15/92	4.00	7.8	
6/29/92	7.75	8.0	
7/13/92	24.10	8.2	
7/27/92	1.50	7.4	
8/10/92	12.80	7.1	
8/25/92	7.50	7.5	
8/28/92	82.40	8.2	
9/8/92	12.90	7.8	
9/18/92	1.00	8.4	
9/21/92	1.00	8.0	
10/5/92	122.00	7.6	
10/19/92	3.70	7.7	1
11/3/92	3.30	7.9	
11/13/92	16.00	9.1	
12/1/92	27.30	7.4	
12/14/92	4.90	6.6	
12/17/92	154.00	9.4	
1/11/93	4.20	7.3	
1/25/93	42.50	8.9	
2/8/93	14.90	7.1	
2/22/93	94.60	7.9	1
3/8/93	12.50	7.3	
3/22/93	8.70	7.5	
3/23/93	483.00	10.4	
4/2/93	7.20	7.0	
4/19/93	2.70	7.2	
5/3/93	2.80	8.2	
5/17/93	3.70	8.5	1
5/31/93	3.90	9.4	
6/14/93	5.50	8.9	
6/28/93	15.00	7.7	
7/6/93	6.60	7.3	
7/19/93	2.90	7.9	
8/9/93	5.30	7.9	
8/23/93	1.60	8.0	
9/7/93	3.80	7.7	
9/21/93	2.60	7.5	
10/7/93	8.20	7.3	
10/18/93	2.00	8.3	
11/4/93	3.40	7.9	
11/15/93	15.10	8.0	
11/29/93	4.10	8.3	
12/5/93	15.60	7.5	
12/13/93	1.00	7.9	

Sediment values reported as zero or "less than" were set to 1.0
Six observations on 9/18/91 were averaged and single values for sediment and pH were reported
The observatios of 9/23/91 and 9/24/91 were averaged and reported for 9/24/91

YC1 Sediment, pH and Specimen Data

Date	Sediment	pH	Specimens
6/19/90	1.00	6.8	67
7/7/90	1.00	6.9	
7/21/90	1.00	7.3	
8/4/90	1.00	7.3	
8/17/90	1.00	7.3	
9/1/90	5.00	7.2	
9/14/90	1.00	7.3	
9/29/90	1.00	7.1	
10/12/90	1.00	6.9	278
10/25/90	6.00	6.8	
11/8/90	1.00	7.0	
11/24/90	12.00	7.2	
12/8/90	1.00	6.7	
12/21/90	2.00	6.5	
1/4/91	4.00	6.4	
1/20/91	1.00	6.7	
2/1/91	2.00	6.7	
2/14/91	1.00	7.2	54
3/1/91	8.75	6.6	
3/15/91	6.74	6.3	
3/28/91	16.04	6.7	
4/11/91	0.97	7.8	60
4/26/91	2.40	6.7	
5/5/91	0.80	6.2	
5/21/91	3.53	6.5	
6/5/91	1.27	7.7	
6/19/91	2.42	6.5	
7/1/91	1.00	6.7	
7/16/91	0.46	6.8	
7/29/91	1.00	6.8	128
8/13/91	1.00	7.1	
8/28/91	4.19	7.7	
9/10/91	8.80	6.5	
9/22/91	1.00	6.8	
10/6/91	2.55	7.7	
10/19/91	1.00	7.7	866
11/2/91	2.81	6.9	
11/17/91	3.63	6.7	
11/22/91	6.51	7.3	
12/1/91	33.98	6.1	
12/2/91	18.67	7.4	
12/17/91	1.00	6.4	
12/30/91	1.00	7.1	
1/13/92	3.20	7.1	
1/27/92	2.40	6.7	160
2/10/92	2.00	7.0	
2/24/92	0.90	7.3	
3/9/92	3.26	7.4	
3/23/92	1.00	7.0	
4/5/92	1.00	7.1	
4/21/92	4.00	7.2	
5/4/92	1.00	7.2	
5/18/92	1.00	7.0	30
6/1/92	1.00	7.4	
6/15/92	3.00	7.5	
6/29/92	3.90	7.0	
7/13/92	2.20	7.4	
7/27/92		6.5	
8/10/92	2.50	6.6	138

Sediment values reported as zero or "less than" were set to 1.0

YC5 Sediment, pH, and Specimen Data

Date	Sediment	pH	Specimens
6/18/90	2.00	6.8	313
7/7/90	2.00	6.6	
7/11/90	2.00	6.8	
7/21/90	1.00	6.8	
8/4/90	1.00	7.0	
8/17/90	3.00	6.9	
9/1/90	1.00	6.8	
9/14/90	662.00	6.8	
9/29/90	1.00	6.8	
10/12/90	1.00	6.8	633
10/18/90	9.00	7.1	
10/25/90	1.00	6.6	
11/8/90	1.00	6.8	
11/24/90	6.00	6.9	
12/8/90	1.00	6.8	
12/20/90	3.00	6.7	
12/24/90	22.00	6.2	
1/4/91	4.00	6.5	
1/20/91	1.00	6.6	
2/1/91	1.00	6.5	
2/14/91	7.00	6.4	147
2/18/91	20.00	6.6	
3/1/91	7.24	6.8	
3/15/91	7.61	6.5	
3/23/91	16.80	6.7	
3/28/91	13.88	7.5	
4/11/91	1.00	7.0	112
4/26/91	0.40	7.2	
5/5/91	1.20	6.2	
5/21/91	5.13	6.7	
6/5/91	3.25	6.9	
6/19/91	4.81	6.8	
7/1/91	1.42	6.7	
7/16/91	0.88	6.9	
7/31/91	1.00	7.0	34
8/13/91	1.00	7.0	
8/28/91	430.00	6.8	
9/10/91	1.00	6.6	
9/22/91	1.00	6.6	
10/6/91	4.10	6.7	
10/19/91	1.00	6.9	7
11/2/91	1.62	6.9	
11/17/91	1.00	6.8	
11/22/91	3.65	7.5	
12/1/91	17.21	7.1	
12/2/91	32.48	6.8	
12/17/91	0.80	6.8	
12/30/91	1.00	7.1	
1/13/92	4.43	7.1	
1/27/92	1.62	6.3	47
2/10/92	3.64	7.9	
2/24/92	1.83	7.2	
3/9/92	1.22	6.9	
3/23/92	1.00	6.9	
4/5/92	1.00	7.0	
4/21/92	4.00	7.9	
5/4/92	1.00	7.8	
5/18/92	1.00	7.0	21
6/1/92	1.00	7.3	
6/15/92	4.00	7.2	
6/29/92	1.41	7.0	
7/13/92	3.90	7.4	
7/27/92	1.00	6.5	
8/10/92	0.60	6.5	36
8/25/92	3.10	7.0	
8/28/92	5.90	7.6	
9/8/92	1.60	6.8	
9/18/92	1.00	7.4	
9/21/92	1.00	7.1	
10/5/92	3.00	7.3	
10/19/92	1.20	6.8	44
11/3/92	0.80	7.7	
11/13/92	3.35	6.9	
11/30/92	0.90	7.5	
12/14/92	1.20	6.4	
12/17/92	20.50	8.0	
1/11/93	1.30	7.0	
1/25/93	4.20	7.9	
2/8/93	1.80	7.1	
2/22/93	4.10	7.5	34
3/8/93	0.90	6.9	
3/22/93	3.90	7.3	
3/23/93	123.00	7.6	
4/2/93	7.70	7.2	
4/19/93	3.70	6.9	
5/3/93	1.00	7.3	
5/17/93	2.30	7.3	26
5/31/93	1.70	7.5	
6/14/93	4.10	6.3	
7/6/93	0.90	7.7	
7/19/93	1.10	7.3	
8/9/93	3.30	7.1	
8/23/93	6.20	7.4	
9/7/93	6.70	7.7	
9/21/93	12.30	7.2	
10/7/93	3.30	6.8	
10/18/93	12.60	6.8	
11/4/93	4.40	6.7	
11/15/93	3.20	6.7	
11/29/93	2.60	7.0	
12/5/93	15.00	6.9	
12/13/93	2.30	6.9	

Sediment values which were reported as zero or "less than" were set to 1.0
A pH value of zero on 6/19/91 was set to 6.8, the average of the two adjacent values.

YC5A pH, Sediment, and Specimen Data

Date	Sediment	pH	Specimens
6/18/90	9.00	7.3	182
7/7/90	7.00	7.1	
7/11/90	8.00	7.4	
7/21/90	13.00	7.3	
8/4/90	8.00	7.4	
8/17/90	6.00	7.4	
9/1/90	5.00	7.3	
9/14/90	10.00	7.3	
9/29/90	1.00	7.3	
10/12/90	11.00	7.1	211
10/18/90	14.00	7.2	
10/25/90	3.00	6.7	
11/8/90	1.00	7.4	
11/24/90	9.00	7.2	
12/8/90	2.00	7.1	
12/20/90	2.00	6.7	
12/24/90	24.00	6.3	
1/4/91	5.00	6.7	
1/20/91	1.00	6.8	
2/1/91	3.00	6.8	
2/14/91	10.00	6.5	
2/18/91	21.00	6.3	215
3/1/91	2.41	7.1	
3/15/91	4.43	6.3	
3/23/91	17.20	6.6	
3/28/91	13.60	7.6	
4/11/91	2.41	7.5	238
4/26/91	3.20	6.7	
5/5/91	1.21	6.3	
5/21/91	3.54	6.6	
6/5/91	4.99	7.1	
6/19/91	4.79	6.7	
7/1/91	2.59	6.9	
7/16/91	43.47	7.3	
7/31/91	84.66	7.5	102
8/13/91	30.88	8.7	
8/28/91	75.43	7.7	
9/10/91	54.51	7.5	
9/22/91	6.39	7.0	
10/6/91	11.14	7.1	
10/19/91	3.64	7.7	17
11/2/91	78.87	6.9	
11/17/91	16.22	6.8	
11/22/91	118.27	7.7	
12/1/91	227.94	7.8	
12/2/91	37.45	6.3	
12/17/91	5.87	6.5	
12/30/91	1.60	7.3	
1/13/92	5.60	6.6	
1/27/92	0.80	6.6	113
2/10/92	6.11	7.1	
2/24/92	2.26	7.4	
3/9/92	1.62	7.5	
3/23/92	0.40	7.2	
4/5/92	1.00	7.5	
4/21/92	4.00	6.7	
5/4/92	1.00	7.7	
5/18/92	1.00	7.9	21
6/1/92	1.00	7.8	
6/15/92	3.00	7.5	
6/29/92	7.70	7.8	
7/13/92	12.60	7.8	
7/27/92	1.50	7.2	
8/10/92	4.00	7.3	19
8/25/92	3.60	7.0	
8/28/92	51.70	8.2	
9/8/92	5.80	7.5	
9/18/92	1.00	8.0	
9/21/92	1.00	8.2	
10/5/92	15.20	7.8	
10/19/92	3.40	7.8	
11/3/92	2.30	7.3	
11/13/92	8.75	7.6	
11/30/92	11.10	7.3	
12/14/92	2.40	6.5	
12/17/92	14.40	8.0	
1/11/93	4.80	7.0	
1/25/93	5.10	8.8	
2/8/93	9.00	7.5	
2/22/93	9.80	7.3	8
3/8/93	5.10	7.0	
3/22/93	9.20	7.5	
3/23/93	150.00	8.1	
4/2/93	8.90	7.2	
4/19/93	4.10	6.9	
5/3/93	1.10	7.8	
5/17/93	1.00	8.2	57
5/31/93	5.20	9.3	
6/14/93	2.80	9.0	
7/6/93	5.30	7.6	
7/19/93	2.30	7.5	
8/9/93	4.40	7.8	
8/23/93	2.20	7.8	
9/7/93	503.00	7.5	
9/21/93	2.20	7.4	
10/7/93	5.30	7.3	
10/18/93	3.70	7.9	
11/4/93	3.00	7.5	
11/15/93	8.80	7.6	
11/29/93	4.00	8.1	
12/5/93	17.20	7.1	
12/13/93	1.70	7.4	

Sediment values reported as zero or "less than" were set to 1.0.

YC12 Sediment, pH, and Specimen Data

Date	Sediment	pH	Specimens
6/18/90	6.00	7.2	53
7/7/90	10.00	7.0	
7/21/90	8.00	7.2	
8/4/90	4.00	7.3	
8/17/90	2.00	7.2	
9/1/90	6.00	7.2	
9/14/90	17.00	7.3	
9/29/90	18.00	7.2	
10/12/90	5.00	7.2	
10/18/90	10.00	7.1	184
10/25/90	1.00	6.9	
11/8/90	1.00	7.0	
11/24/90	8.00	7.2	
12/8/90	2.00	6.7	
12/21/90	4.00	7.2	
12/24/90	28.00	6.5	
1/4/91	4.00	6.7	
1/20/91	2.00	6.8	
2/1/91	2.00	6.7	
2/14/91	17.00	6.8	76
3/1/91	2.77	6.8	
3/15/91	4.02	6.6	
3/28/91	11.64	7.4	
4/11/91	0.48	6.9	76
4/26/91	2.40	7.2	
5/5/91	2.39	6.5	
5/21/91	8.39	6.8	
6/5/91	16.16	7.2	
6/19/91	4.36	6.8	
7/1/91	11.92	7.0	
7/16/91	3.81	7.2	
7/30/91	28.46	7.4	47
8/13/91	12.90	7.2	
8/28/91	6.85	7.1	
9/10/91	18.04	7.0	
9/22/91	3.19	7.0	
10/6/91	7.18	7.1	
10/19/91	2.02	7.0	29
11/2/91	2.07	6.9	
11/17/91	2.80	6.9	
11/22/91	60.67	7.6	
12/1/91	94.29	7.5	
12/2/91	106.08	6.6	
12/17/91	9.27	6.5	
12/30/91	1.00	6.8	
1/13/92	4.46	7.0	
1/27/92	0.40	6.4	34
2/10/92	4.44	6.9	
2/24/92	2.74	6.9	
3/9/92	5.63	7.0	
3/23/92	1.00	6.9	
4/5/92	1.00	6.9	
4/21/92	65.00	7.4	
5/4/92	1.00	7.5	
5/18/92	1.00	7.5	40
6/1/92	10.00	7.6	
6/15/92	7.00	7.5	
6/29/92	6.64	7.5	
7/13/92	9.30	7.0	
7/27/92	20.60	6.8	
8/10/92	4.60	6.8	17
8/25/92	4.30	7.5	
8/28/92	59.20	7.4	
9/8/92	12.30	7.3	
9/21/92	1.00	7.2	
10/5/92	20.90	7.3	
10/19/92	6.10	7.0	9
11/3/92	7.80	7.4	
11/13/92	11.50	7.0	
11/30/92	4.60	7.2	
12/14/92	2.60	6.7	
12/17/92	37.20	7.8	
1/11/93	3.20	6.9	
1/25/93	10.40	7.7	
2/8/93	3.20	7.1	
2/22/93	10.20	7.3	3
3/8/93	2.70	7.0	
3/22/93	8.60	6.8	
3/23/93	230.00	7.9	
4/2/93	9.80	7.1	
4/19/93	0.40	6.9	
5/3/93	1.50	7.2	
5/17/93	5.60	7.2	13
5/31/93	7.10	7.4	
6/14/93	6.90	7.3	
7/6/93	5.30	8.0	
7/19/93	13.90	7.5	
8/9/93	8.40	7.3	
8/23/93	3.50	7.4	
9/7/93	29.20	7.4	
9/21/93	4.80	7.4	

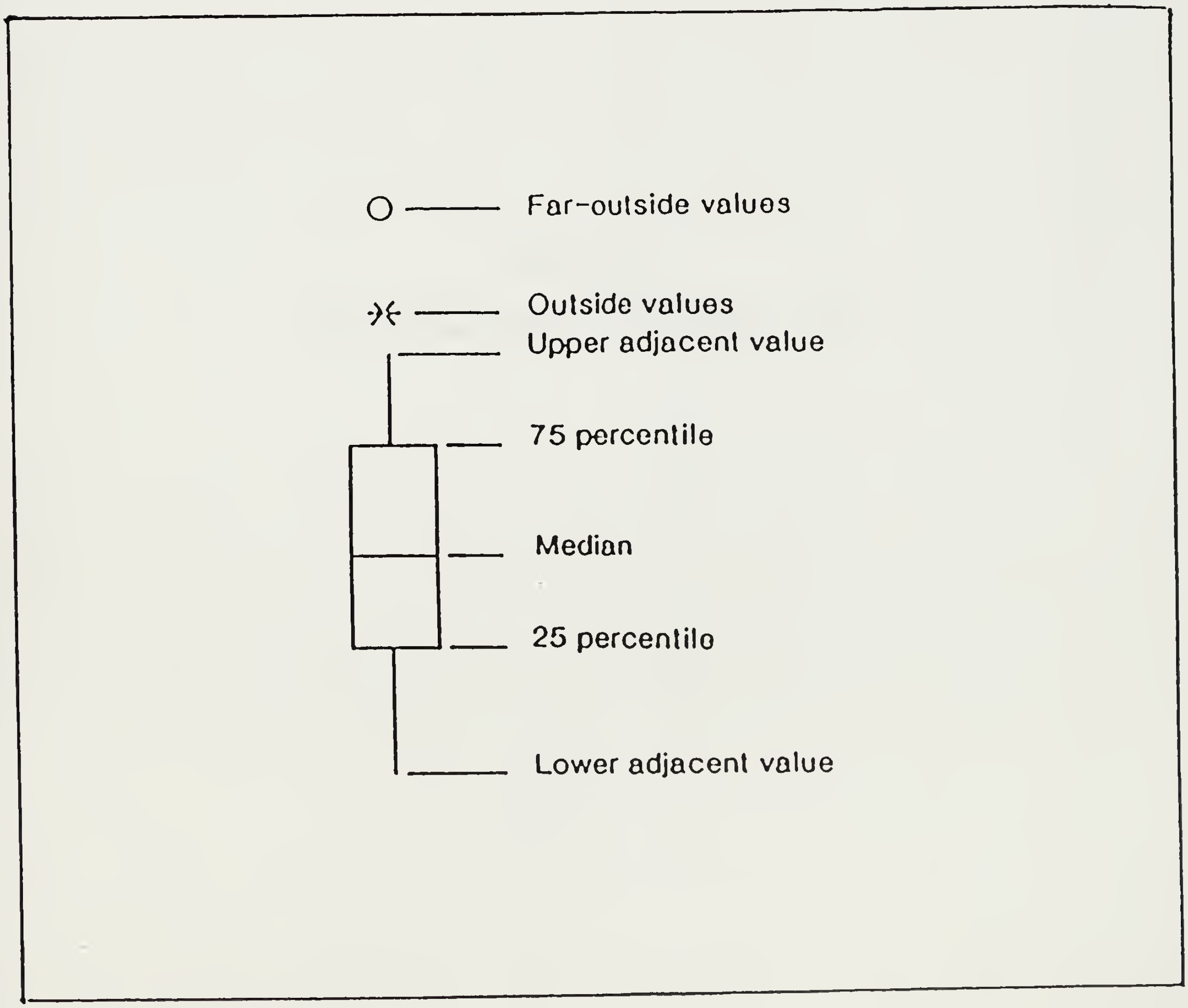
Sediment values reported as zero or "less than" were set to 1.0.

Appendix G

Tukey Boxplots

Tukey Boxplots

A boxplot (sometimes known as a box-and-whisker plot) is a concise, graphical display for summarizing the distribution of a data set. It consists of a center line (the median) that splits a rectangle defined by the "upper and lower hinges" located at the 75th and 25th percentiles, respectively. The box denotes the "interquartile range." The "whiskers" are lines drawn from the ends of the box to to the last observations within 1.5 times theinterquartile range beyond either end of the box. These observations are the "upper and lower adjacent values." "Outside values" are defined as values lying between 1.5 and 3.0 times the interquartile range beyond the ends of the box, and are denoted with asterisks. "Far outside values" are defined as values which are greater than 3.0 times the interquartile range, and are denoted with circles.



Appendix H

Daily sampling data from Station TC10 - 1993

26/93

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

E	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
/01/93	TC10	6.2	6	0.00	0.00	0.2	0.00	24HR	0.02
/02/93	TC10	8.2	5	0.00	0.00	0.2	0.00	24HR	0.00
03/93	TC10	8.0	3	2.70	7.90	0.3	0.00	GRAB	0.00
/04/93	TC10	7.9	4	0.66	7.90	0.2	0.00	24HR	0.00
/05/93	TC10	7.7	24	2.50	28.60	0.3	0.00	24HR	0.68
06/93	TC10	6.5	16	3.40	12.00	0.3	7.75	24HR	0.00
07/93	TC10	6.6	8	2.80	23.80	0.3	0.00	24HR	0.00
/08/93	TC10	7.2	18	3.10	21.55	0.5	0.60	24HR	0.00
/09/93	TC10	7.1	30	1.67	62.81	0.4	3.75	24HR	0.54
10/93	TC10	7.3	9	2.30	6.48	0.2	0.00	24HR	0.01
/11/93	TC10	7.3	5	2.50	3.90	0.2	0.00	24HR	0.43
/12/93	TC10	7.6	60	2.80	56.00	0.5	0.00	24HR	0.18
/13/93	TC10	7.2	42	3.00	32.60	0.3	0.00	24HR	0.02
/14/93	TC10	7.6	40	2.60	44.00	0.2	0.75	24HR	0.00
/15/93	TC10	7.5	52	2.80	40.50	0.5	4.75	GRAB	0.00
/16/93	TC10	8.2	21	1.40	52.02	0.5	0.00	24HR	0.00
/17/93	TC10	7.8	25	3.30	33.94	0.3	0.00	24HR	0.00
/18/93	TC10	7.7	10	2.50	13.66	0.2	0.00	24HR	0.00
/19/93	TC10	7.6	9	2.20	4.00	0.2	0.80	24HR	0.01
/20/93	TC10	7.0	32	2.10	19.90	0.3	6.10	24HR	0.00
/21/93	TC10	7.3	15	2.50	11.90	0.3	0.00	24HR	0.42
/22/93	TC10	7.1	65	1.60	79.50	0.6	0.00	24HR	0.00
/23/93	TC10	6.8	5	2.60	32.25	0.3	0.00	24HR	0.00
/24/93	TC10	8.5	17	4.08	60.98	0.4	1.30	24HR	0.93
/25/93	TC10	8.9	67	4.10	131.00	0.8	3.35	24HR	0.00
/26/93	TC10	7.6	35	3.10	35.97	0.7	0.08	24HR	0.00
/27/93	TC10	9.1	6	3.20	19.80	0.4	3.85	24HR	0.00
/28/93	TC10	4.6	12	2.60	15.80	0.4	2.40	24HR	0.00
/29/93	TC10	4.2	3	1.90	19.80	0.4	1.50	24HR	0.00
/30/93	TC10	3.7	5	2.20	9.90	0.6	0.40	GRAB	0.00
/31/93	TC10	8.3	35	2.20	71.73	0.5	0.00	24HR	0.00
*************************									
x.		9.1			131.00	0.8	7.75		0.93
n.		3.7			0.00	0.2	0.00		
erage		7.3			30.97	0.4	1.21		
TAL									** 3.24**

04/26/93

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

ATE	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
02/01/93	TC10	8.3	14	1.30	20.10	0.2	0.00	24HR	0.00
02/02/93	TC10	7.4	25	2.20	99.30	0.7	1.05	24HR	0.00
02/03/93	TC10	5.0	6	1.10	39.60	0.7	5.15	24HR	0.00
02/04/93	TC10	8.2	5	2.80	16.00	0.5	2.50	24HR	0.00
02/05/93	TC10	9.7	8	1.80	24.00	0.8	0.00	24HR	0.00
02/06/93	TC10	11.9	30	1.49	302.16	1.0	0.00	24HR	0.00
02/07/93	TC10	9.5	40	1.48	162.98	0.8	0.00	24HR	0.00
02/08/93	TC10	7.1	15	1.80	31.90	0.5	0.45	24HR	0.00
02/09/93	TC10	4.9	10	1.60	16.00	1.2	2.60	24HR	0.00
02/10/93	TC10	3.5	36	2.00	31.80	1.6	3.35	24HR	0.00
02/11/93	TC10	6.9	30	1.30	76.20	1.0	2.30	24HR	0.14
02/12/93	TC10	3.5	9	0.80	116.60	0.9	3.20	24HR	0.49
02/13/93	TC10	3.4	40	1.90	153.28	1.8	2.00	24HR	0.05
02/14/93	TC10	8.9	14	1.79	59.19	0.6	0.00	24HR	0.04
02/15/93	TC10	9.0	22	1.90	36.20	0.4	0.00	24HR	0.02
02/16/93	TC10	10.5	53	3.70	112.30	1.0	5.35	24HR	0.81
02/17/93	TC10	9.8	80	2.10	259.38	0.8	3.75	24HR	0.01
02/18/93	TC10	11.2	35	1.90	48.00	1.7	0.00	GRAB	0.00
02/19/93	TC10	8.0	25	4.90	20.40	0.6	3.30	GRAB	0.00
02/20/93	TC10	4.9	6	1.70	37.19	1.0	0.20	GRAB	0.00
02/21/93	TC10	9.3	17	3.60	92.18	1.0	0.30	24HR	1.07
02/22/93	TC10	7.9	25	4.30	103.84	0.6	0.90	24HR	0.00
02/23/93	TC10	7.4	15	2.50	71.60	0.6	1.75	24HR	0.00
02/24/93	TC10	7.9	20	2.60	64.00	0.6	0.90	24HR	0.00
02/25/93	TC10	5.1	39	4.10	86.58	0.6	0.30	24HR	0.22
02/26/93	TC10	8.5	28	2.40	37.40	0.7	2.00	24HR	0.39
02/27/93	TC10	7.0	25	2.70	40.31	0.5	0.00	GRAB	0.00
02/28/93	TC10	8.3	33	2.70	52.14	0.5	0.00	24HR	0.00
ax.		11.9			302.16	1.8	5.35		1.07
in.		3.4			16.00	0.2	0.00		
verage		7.6			78.95	0.8	1.48		
OTAL									** 3.24*

/26/93

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

TE	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
3/01/93	TC10	7.1	5	2.30	4.00	0.2	0.63	GRAB	0.00
/02/93	TC10	9.3	17	2.50	24.00	0.4	0.50	24HR	0.08
/03/93	TC10	7.3	21	1.80	24.10	0.4	0.00	24HR	0.13
3/04/93	TC10	7.7	27	3.90	31.90	0.4	0.00	24HR	0.80
3/05/93	TC10	7.3	12	3.50	12.00	0.2	0.50	24HR	0.11
/06/93	TC10	7.4	0	0.00	15.90	0.4	0.00	24HR	0.00
3/07/93	TC10	8.4	0	3.40	8.00	0.3	0.00	GRAB	0.05
3/08/93	TC10	7.8	10	3.40	8.00	0.3	0.00	24HR	0.17
/09/93	TC10	7.2	0	3.25	3.90	0.5	0.00	24HR	0.00
3/10/93	TC10	7.4	4	2.50	0.00	0.3	0.00	24HR	0.03
3/11/93	TC10	7.0	4	1.80	4.00	0.3	0.00	24HR	0.00
3/12/93	TC10	7.2	7	1.30	7.90	0.4	0.00	24HR	0.05
3/16/93	TC10	7.5	2	2.60	4.00	0.4	0.00	24HR	0.00
3/17/93	TC10	7.3	7	4.40	11.90	0.3	1.30	24HR	0.13
3/18/93	TC10	7.3	8	4.30	0.00	0.3	0.00	24HR	0.01
3/19/93	TC10	7.3	8	4.10	15.90	0.3	3.00	24HR	0.00
3/20/93	TC10	7.2	12	4.40	22.00	0.4	0.00	24HR	0.07
3/21/93	TC10	8.0	9	4.80	10.79	0.3	0.00	24HR	0.10
3/22/93	TC10	7.5	7	4.70	3.90	0.1	0.00	24HR	0.03
3/23/93	TC10	10.4	200	0.00	171.00	2.3	0.00	GRAB	3.06
3/24/93	TC10	9.5	200	7.90	16.40	0.3	0.00	24HR	0.12
3/25/93	TC10	7.7	21	3.80	119.10	0.4	0.00	24HR	0.00
3/26/93	TC10	7.5	9	5.80	12.10	0.4	3.50	24HR	0.00
3/27/93	TC10	7.5	11	6.20	55.23	0.7	0.00	24HR	0.80
3/28/93	TC10	7.9	8	4.60	13.10	0.2	0.00	24HR	0.01
3/29/93	TC10	7.8	10	3.10	8.00	0.3	0.60	24HR	0.00
3/30/93	TC10	7.3	6	3.50	8.00	0.2	1.90	24HR	0.00
3/31/93	TC10	7.4	9	3.80	12.20	0.3	0.50	24HR	0.32
ax.		10.4			171.00	2.3	3.50		3.06
in.		7.0			0.00	0.1	0.00		
verage		7.7			22.40	0.4	0.44		
OTAL									** 6.07**

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
/01/93	TC10	7.8	5	3.00	4.00	0.2	3.80	24HR	0.11
4/02/93	TC10	7.0	6	3.20	12.00	0.4	1.40	24HR	0.21
/03/93	TC10	10.1	16	2.70	4.80	0.3	0.00	24HR	0.00
/04/93	TC10	7.9	8	2.70	19.70	0.2	0.00	24HR	0.00
4/05/93	TC10	7.1	4	3.00	1.10	0.4	0.00	24HR	0.49
/06/93	TC10	7.7	4	2.80	1.10	0.3	0.00	24HR	0.03
/07/93	TC10	7.6	6	2.30	3.10	0.2	0.00	GRAB	0.00
/08/93	TC10	7.6	6	2.40	7.90	0.2	0.00	24HR	0.00
/10/93	TC10	7.6	4	3.20	6.10	0.5	0.30	GRAB	0.06
/11/93	TC10	8.8	3	2.50	3.50	0.3	0.00	24HR	0.00
/12/93	TC10	7.2	1	3.40	4.00	0.2	0.00	24HR	0.00
4/13/93	TC10	7.2	2	3.20	2.30	0.2	0.00	24HR	0.00
/14/93	TC10	7.4	4	2.40	3.90	0.3	0.00	24HR	0.00
/15/93	TC10	7.4	2	2.50	7.90	0.3	2.10	24HR	0.17
/16/93	TC10	7.1	2	2.70	12.00	0.4	0.00	24HR	0.63
/17/93	TC10	7.7	2	2.90	6.10	0.5	1.30	GRAB	0.01
/18/93	TC10	8.5	2	3.00	3.10	0.3	0.00	24HR	0.00
/19/93	TC10	7.2	2	3.00	4.00	0.2	0.60	24HR	0.00
/20/93	TC10	7.5	2	2.60	4.00	0.4	0.85	24HR	0.40
/21/93	TC10	7.5	3	2.50	8.00	0.4	0.00	24HR	0.43
/22/93	TC10	7.5	1	2.30	8.00	0.3	0.00	24HR	0.05
/23/93	TC10	7.5	1	3.00	4.00	0.4	0.00	24HR	0.00
/24/93	TC10	7.2	3	1.70	7.60	0.5	0.30	24HR	0.00
/25/93	TC10	8.6	3	2.40	6.40	0.2	0.00	24HR	0.00
5/93	TC10	7.1	10	4.70	24.00	0.3	18.00	24HR	0.90
/27/93	TC10	6.8	8	2.60	8.00	0.3	0.00	24HR	0.00
/28/93	TC10	7.2	3	2.50	4.00	0.4	0.00	24HR	0.00
/29/93	TC10	7.4	4	2.70	4.00	0.4	0.00	24HR	0.00
/30/93	TC10	7.4	2	25.00	4.00	0.4	0.00	24HR	0.00
.		10.1			24.00	0.5	18.00		0.90
n.		6.8			1.10	0.2	0.00		
erage		7.6			6.50	0.3	0.99		
AL									** 3.49**

/13/93

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
01/93	TC10	7.5	1	2.67	3.10	0.3	0.00	24HR	0.00
02/93	TC10	9.2	3	2.81	6.20	0.1	0.00	GRAB	0.00
03/93	TC10	8.2	4	2.50	4.00	0.3	0.00	GRAB	0.00
04/93	TC10	7.4	4	2.50	8.00	0.6	0.00	24HR	0.36
05/93	TC10	7.3	4	2.10	4.00	0.2	0.00	24HR	0.00
06/93	TC10	7.2	1	2.30	0.00	0.6	0.00	24HR	0.00
07/93	TC10	7.2	1	2.20	4.00	0.4	1.50	24HR	0.00
08/93	TC10	8.2	3	1.80	10.60	0.6	0.00	24HR	0.00
09/93	TC10	9.1	2	2.40	4.00	0.4	0.00	24HR	0.00
10/93	TC10	7.8	4	2.20	28.00	0.2	0.00	24HR	0.00
11/93	TC10	7.4	2	1.50	8.00	0.5	0.00	24HR	0.00
12/93	TC10	8.5	2	1.60	4.00	0.4	0.00	24HR	0.00
13/93	TC10	7.2	3	1.50	4.00	0.5	0.00	24HR	0.34
14/93	TC10	7.9	2	1.60	4.00	0.5	0.00	24HR	0.01
15/93	TC10	6.3	3	1.90	6.70	0.6	0.00	24HR	0.00
16/93	TC10	9.5	5	1.70	12.40	0.4	0.00	24HR	0.00
17/93	TC10	8.5	2	0.78	8.00	0.2	0.00	24HR	0.05
18/93	TC10	7.0	3	2.20	12.00	0.4	0.00	24HR	0.23
19/93	TC10	9.0	2	1.60	8.00	0.4	0.00	GRAB	0.72
20/93	TC10	8.1	3	1.10	8.00	0.3	0.00	GRAB	0.04
21/93	TC10	8.5	2	1.80	4.00	0.3	0.00	24HR	0.26
22/93	TC10	7.3	2	1.60	8.80	0.4	0.00	24HR	0.00
23/93	TC10	10.4	2	1.90	7.30	0.3	0.00	24HR	0.00
24/93	TC10	8.8	1	0.71	0.00	0.2	0.00	24HR	0.00
5/93	TC10	7.1	5	1.20	4.00	0.3	0.00	24HR	0.37
26/93	TC10	7.1	2	1.30	123.50	0.3	0.00	24HR	0.51
27/93	TC10	10.1	1	1.06	4.00	0.5	0.00	24HR	0.00
28/93	TC10	5.9	2	0.68	8.00	0.5	0.00	24HR	0.00
29/93	TC10	8.7	1	0.00	6.00	0.5	0.00	24HR	0.15
30/93	TC10	10.4	1	2.05	2.00	0.5	0.00	24HR	0.05
31/93	TC10	9.4	6	0.81	3.00	0.2	0.00	24HR	0.25
		10.4			123.50	0.6	1.50		0.72
		5.9			0.00	0.1	0.00		
rage		8.1			10.25	0.4	0.05		
AL									** 3.34**

TUNNEL PROJECT
NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

E	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
6/01/93	TC10	9.1	2	1.00	1.00	0.4	0.00	24HR	0.02
6/02/93	TC10	7.1	1	1.00	1.00	0.4	0.00	24HR	0.00
/03/93	TC10	6.9	1	1.20	12.00	0.6	0.00	GRAB	0.00
/04/93	TC10	7.2	1	0.57	28.00	0.9	0.00	24HR	0.07
6/05/93	TC10	6.7	2	1.00	4.60	0.5	0.00	GRAB	0.00
/06/93	TC10	10.3	4	1.50	12.30	0.6	0.00	24HR	0.00
/07/93	TC10	8.7	1	1.20	4.00	0.2	0.00	24HR	0.04
6/08/93	TC10	7.3	3	1.40	8.00	3.3	0.00	24HR	0.00
6/09/93	TC10	7.2	3	1.20	11.80	0.7	0.00	24HR	0.00
/10/93	TC10	7.1	2	1.60	4.00	1.3	0.00	24HR	0.00
/11/93	TC10	6.7	3	1.30	4.00	0.6	0.00	24HR	0.11
6/12/93	TC10	7.8	4	0.48	18.60	0.7	0.00	24HR	0.54
/13/93	TC10	10.0	0	0.00	0.00	0.2	0.00	GRAB	0.20
/14/93	TC10	8.9	4	1.10	8.00	0.3	0.00	24HR	0.01
6/15/93	TC10	6.5	4	1.00	4.00	3.3	0.00	24HR	0.25
/16/93	TC10	7.4	3	0.92	8.00	0.8	0.00	24HR	0.00
/17/93	TC10	6.2	1	1.00	4.00	0.7	0.00	24HR	0.00
/18/93	TC10	8.8	1	1.10	4.00	0.7	0.00	24HR	0.00
/19/93	TC10	8.8	3	0.00	0.00	0.6	1.25	24HR	0.00
/20/93	TC10	9.9	7	0.00	0.02	0.8	0.00	24HR	0.15
/21/93	TC10	8.7	1	1.20	4.00	0.3	0.00	24HR	0.11
6/22/93	TC10	7.4	2	1.10	12.00	0.5	0.00	24HR	0.36
/23/93	TC10	8.6	1	1.30	8.00	0.6	0.90	24HR	0.00
24/93	TC10	8.0	2	1.30	12.00	0.6	2.00	24HR	0.00
25/93	TC10	10.2	3	0.81	16.00	0.4	8.30	24HR	0.00
/26/93	TC10	7.3	4	1.40	6.80	0.3	0.00	24HR	0.47
~~/27/93~~	~~TC10~~	~~0.0~~	~~0~~	~~0.00~~	~~0.00~~	~~0.0~~	~~0.00~~		~~0.00~~
/27/93	TC10	10.0	1	1.50	0.00	0.5	0.00	24HR	0.00
/28/93	TC10	7.7	3	1.20	4.00	0.4	6.00	24HR	0.30
/29/93	TC10	6.4	3	1.40	4.00	0.5	0.00	24HR	0.01
/30/93	TC10	9.0	5	0.00	4.00	0.2	6.30	24HR	0.00
.		10.3			28.00	3.3	8.30		0.54
.		0.0			0.00	0.0	0.00		
verage		7.8			6.72	0.7	0.80		
TAL									** 2.64**

NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

ATE	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
7/01/93	TC10	7.5	8	0.96	4.00	0.3	3.70	GRAB	0.72
7/02/93	TC10	5.6	3	1.10	20.00	0.5	0.60	24HR	0.00
7/03/93	TC10	7.1	4	1.90	4.60	0.8	0.00	GRAB	0.00
7/04/93	TC10	10.2	1	1.50	0.00	0.2	0.00	24HR	0.00
7/05/93	TC10	8.7	1	1.40	0.00	0.1	0.00	24HR	0.00
7/06/93	TC10	7.3	12	2.00	4.00	0.2	2.00	24HR	0.00
7/07/93	TC10	7.9	2	1.00	4.00	0.4	0.05	24HR	0.00
7/08/93	TC10	7.9	3	1.30	4.00	0.6	1.30	24HR	0.00
7/09/93	TC10	7.0	4	0.98	4.00	0.4	0.00	24HR	0.09
7/10/93	TC10	6.5	5	1.27	12.30	0.6	0.60	24HR	0.02
7/11/93	TC10	8.9	3	1.10	12.00	0.6	0.00	24HR	0.25
7/12/93	TC10	7.3	5	1.20	16.00	0.6	0.00	24HR	0.00
7/13/93	TC10	6.5	3	1.10	4.00	0.4	0.00	24HR	0.12
7/14/93	TC10	6.8	3	1.10	4.00	0.5	0.00	24HR	0.20
7/15/93	TC10	7.4	1	0.72	4.00	0.9	0.00	24HR	0.78
7/16/93	TC10	7.5	2	0.00	4.00	1.2	0.00	24HR	0.00
7/17/93	TC10	7.0	1	2.20	5.60	0.4	0.00	24HR	0.00
7/18/93	TC10	10.3	15	2.00	8.00	0.4	0.00	24HR	0.90
7/19/93	TC10	7.9	8	0.50	8.00	0.3	0.00	24HR	0.00
7/20/93	TC10	7.2	2	1.00	3.00	0.4	0.00	24HR	0.39
7/21/93	TC10	7.2	3	0.50	6.00	0.5	0.00	24HR	0.00
7/22/93	TC10	6.9	3	0.90	8.00	0.4	0.00	24HR	0.00
7/23/93	TC10	7.0	2	0.40	2.00	0.4	0.00	24HR	0.00
7/24/93	TC10	7.1	0	0.00	7.70	0.3	0.00	24HR	0.00
7/25/93	TC10	10.6	1	1.90	4.00	0.2	0.00	24HR	0.00
7/26/93	TC10	7.9	1	1.60	1.00	0.4	0.00	24HR	0.00
7/27/93	TC10	6.7	4	2.05	4.80	0.5	0.00	24HR	0.00
7/28/93	TC10	7.1	2	1.80	7.60	0.0	0.00	24HR	0.00
7/29/93	TC10	7.1	3	1.70	5.98	0.3	0.00	24HR	0.00
7/30/93	TC10	7.4	2	1.40	4.40	0.0	0.00	24HR	0.00
7/31/93	TC10	7.1	2	1.70	5.20	0.0	0.00	24HR	0.00
8/01/93	TC10	9.8	2	1.50	4.00	0.0	0.00	24HR	0.00
8/02/93	TC10	7.7	12	3.10	19.50	0.0	0.00	24HR	0.57
8/03/93	TC10	7.6	3	1.10	4.00	0.0	0.00	24HR	0.00
8/04/93	TC10	7.4	3	1.00	4.00	0.0	0.00	24HR	0.10
8/05/93	TC10	7.4	2	0.90	4.00	0.0	0.00	24HR	0.00
8/06/93	TC10	7.2	1	2.20	2.00	0.0	0.00	24HR	0.48
8/07/93	TC10	6.7	4	1.30	13.70	0.0	0.00	24HR	0.00
8/08/93	TC10	7.6	0	1.60	4.00	0.0	0.00	24HR	0.00
8/09/93	TC10	7.9	3	0.91	0.00	0.0	0.00	24HR	0.00
8/10/93	TC10	7.8	3	0.90	4.00	0.0	0.00	24HR	0.00
8/11/93	TC10	7.6	2	1.00	4.00	0.0	0.00	24HR	1.03
8/12/93	TC10	7.5	2	1.80	0.00	0.0	0.00	24HR	1.28
8/13/93	TC10	7.5	0	1.50	12.00	0.0	0.00	24HR	1.09
8/14/93	TC10	7.5	8	1.90	14.20	0.0	0.00	24HR	0.02
8/15/93	TC10	7.6	2	2.20	7.20	0.0	0.00	24HR	0.00
8/16/93	TC10	7.8	2	1.00	4.00	0.0	0.00	24HR	0.00
8/17/93	TC10	6.7	3	0.70	0.00	0.0	0.00	24HR	0.00
8/18/93	TC10	7.1	4	0.30	8.00	0.0	0.00	24HR	0.00
8/19/93	TC10	7.2	2	0.50	4.00	0.0	0.00	24HR	0.00
8/20/93	TC10	7.0	2	1.00	0.00	0.0	0.00	24HR	0.32
8/21/93	TC10	7.0	3	1.10	3.00	0.0	0.00	24HR	0.00
8/22/93	TC10	7.2	4	1.30	3.00	0.0	0.00	24HR	0.00
8/23/93	TC10	8.0	2	1.00	2.00	0.0	0.00	24HR	0.00
8/24/93	TC10	7.5	1	1.10	4.00	0.0	0.00	24HR	0.00
8/25/93	TC10	7.5	3	[illegible]	3.00	[illegible]	0.00	24HR	[illegible]

NO DATA

[illegible]

NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

ATE	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
/26/93	TC10	7.3	2	1.00	3.00	0.0	0.00	24HR	0.03
/27/93	TC10	7.2	2	0.90	3.00	0.0	0.00	24HR	0.00
/28/93	TC10	7.4	0	0.00	7.30	0.0	0.00	24HR	0.00
/29/93	TC10	7.8	2	1.40	11.90	0.0	0.00	24HR	0.00
/30/93	TC10	7.9	0	1.20	8.00	0.0	0.00	24HR	0.00
/31/93	TC10	7.5	0	0.90	4.00	0.2	0.00	24HR	0.00
/01/93	tc10	7.3	3	0.90	7.90	0.2	0.00	24hr	0.00
/02/93	TC10	7.5	4	1.00	4.10	0.2	0.00	24HR	0.08
/03/93	TC10	7.4	3	1.10	4.00	0.0	0.00	24HR	0.05
/04/93	TC10	7.9	7	1.60	10.80	0.4	0.00	24HR	0.42
/05/93	TC10	8.7	3	1.50	4.80	0.3	0.00	24HR	0.00
/06/93	TC10	8.4	0	1.70	1.60	0.3	0.00	GRAB	0.00
/07/93	TC10	7.7	2	1.50	16.00	0.2	0.00	24HR	0.00
/08/93	TC10	7.6	3	1.20	12.00	0.3	0.00	24HR	0.78
/09/93	TC10	7.4	8	0.95	4.00	0.4	0.00	24HR	0.00
/10/93	TC10	7.5	0	0.92	4.90	0.4	0.00	24HR	0.00
/11/93	TC10	7.4	6	1.40	9.01	0.4	0.00	24HR	0.00
/12/93	TC10	7.8	5	1.20	4.10	0.3	0.00	24HR	0.00
/13/93	TC10	8.3	2	1.20	4.10	0.3	0.00	24HR	0.00
/14/93	TC10	7.1	0	0.00	4.00	0.5	0.00	24HR	0.00
/15/93	TC10	7.1	0	0.00	0.00	0.5	0.00	24HR	0.35
/16/93	TC10	7.3	0	0.90	4.10	0.5	0.00	24HR	0.64
/17/93	TC10	7.2	0	0.00	0.00	0.5	0.00	24HR	0.00
/18/93	TC10	7.5	0	1.60	8.30	0.4	0.00	24HR	0.00
/19/93	TC10	7.7	0	1.40	12.00	0.3	0.00	24HR	0.00
/20/93	TC10	7.9	2	0.84	8.10	0.2	0.00	24HR	0.00
/21/93	TC10	7.5	3	0.63	0.00	0.3	0.00	24HR	0.00
/22/93	TC10	7.8	3	0.82	8.70	0.3	0.00	24HR	0.00
/23/93	TC10	7.6	2	0.90	4.00	0.4	0.00	24HR	0.02
/24/93	TC10	7.6	9	1.00	4.00	0.5	3.90	24HR	0.00
/25/93	TC10	7.6	0	1.40	2.40	0.3	3.00	24HR	0.30
/26/93	TC10	8.0	14	1.60	7.90	0.3	0.30	24HR	0.60
/27/93	TC10	8.0	7	1.50	3.90	0.2	0.00	24HR	0.43
/28/93	TC10	7.6	9	0.80	4.00	0.3	3.50	24HR	0.00
/29/93	TC10	7.6	0	0.69	0.00	0.2	2.60	24HR	0.00
/30/93	TC10	7.5	0	0.75	4.00	0.3	2.00	24HR	0.00
x.		10.6			20.00	~~1.2~~	3.90		1.28
n.		5.6			0.00	~~0.0~~	0.00		
erage		7.6			5.54	~~0.2~~	0.26		
TAL									**12.06**

NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

TE	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
/01/93	TC10	7.6	0	0.72	4.00	0.3	0.00	24HR	0.00
/03/93	TC10	7.9	3	1.20	0.00	0.2	0.00	24HR	0.35
/04/93	TC10	8.0	3	1.30	4.00	0.2	0.00	24HR	0.00
/05/93	TC10	7.7	4	1.10	4.00	0.2	0.00	24HR	0.00
/06/93	TC10	7.4	10	1.50	7.90	0.3	0.00	24HR	0.00
/07/93	TC10	7.3	1	0.67	8.00	0.2	0.00	24HR	0.00
/08/93	TC10	7.5	0	0.80	7.30	0.2	2.00	24HR	0.00
/09/93	TC10	7.5	4	0.80	3.70	0.1	3.00	24HR	0.78
/10/93	TC10	8.1	30	1.10	4.00	0.4	0.30	24HR	1.07
/11/93	TC10	8.0	11	0.98	23.90	0.3	0.00	24HR	0.00
/12/93	TC10	8.1	7	1.10	4.00	0.2	0.00	24HR	0.36
/13/93	TC10	7.7	6	1.00	0.00	0.2	0.60	24HR	0.00
/14/93	TC10	7.5	6	0.90	4.00	0.3	0.30	24HR	0.00
/15/93	TC10	7.5	0	0.89	4.00	0.3	0.00	24HR	0.00
/16/93	TC10	7.1	7	1.60	5.70	0.2	0.30	GRAB	0.05
/17/93	TC10	7.6	0	1.20	4.00	0.3	0.00	24HR	0.09
/18/93	TC10	8.3	5	0.89	7.90	0.2	0.30	24HR	0.10
/19/93	TC10	7.8	0	1.20	4.00	0.3	0.00	24HR	0.08
20/93	TC10	7.8	0	1.10	12.10	0.2	0.00	24HR	0.00
21/93	TC10	8.0	0	1.80	12.90	0.4	2.50	24HR	0.34
22/93	TC10	8.1	10	0.00	14.50	0.4	2.00	24HR	0.00
23/93	TC10	8.1	10	0.00	9.90	0.4	4.00	24HR	0.00
24/93	TC10	8.1	0	0.00	7.60	0.2	0.00	GRAB	0.00
25/93	TC10	8.3	1	0.00	8.20	0.3	2.00	24HR	0.00
26/93	TC10	8.0	4	1.20	0.00	0.2	0.00	24HR	0.00
27/93	TC10	7.8	10	0.00	8.00	0.3	3.30	24HR	0.00
28/93	TC10	7.9	6	0.00	4.00	0.3	0.00	24HR	0.00
29/93	TC10	7.7	9	0.65	8.00	0.3	4.50	24HR	0.00
01/93	TC10	8.1	0	1.10	0.00	0.3	0.00	24HR	0.09
02/93	TC10	7.8	0	1.10	3.90	0.6	0.00	GRAB	0.00
03/93	TC10	7.8	0	1.00	8.20	0.2	0.00	GRAB	0.00
04/93	TC10	7.9	4	0.00	0.00	0.2	0.00	GRAB	0.00
05/93	TC10	7.8	0	0.00	4.00	0.2	0.00	24HR	0.30
06/93	TC10	7.9	0	0.84	0.00	0.2	0.00	24HR	0.00
07/93	TC10	8.0	0	0.80	0.00	0.2	0.00	24HR	0.00
08/93	TC10	7.5	0	0.00	0.00	0.2	0.00	24HR	0.00
09/93	TC10	7.7	0	0.85	0.00	0.2	0.00	24HR	0.02
10/93	TC10	7.8	0	0.76	4.00	0.2	0.00	24HR	0.00
11/93	TC10	6.9	5	1.30	4.00	0.2	0.00	24HR	0.00
12/93	TC10	7.0	4	0.70	0.00	0.3	0.00	24HR	0.00
13/93	TC10	8.2	0	1.70	9.30	0.2	0.00	24HR	0.01
14/93	TC10	8.1	0	0.00	0.00	0.2	0.00	24HR	0.00
15/93	TC10	8.0	0	0.58	7.90	0.3	0.00	24HR	0.90
16/93	TC10	8.0	3	0.70	0.00	0.2	0.00	24HR	0.08
17/93	TC10	7.6	3	1.00	0.00	0.2	0.00	24HR	0.00
18/93	TC10	8.1	0	0.90	0.00	0.2	0.00	24HR	0.00
22/93	TC10	7.8	0	1.00	0.00	0.0	0.00	24HR	0.00
23/93	TC10	8.1	4	0.90	0.00	0.0	0.00	24HR	0.00
24/93	TC10	8.2	3	0.80	0.00	0.0	0.00	24HR	0.00
28/93	TC10	8.2	0	1.10	0.00	0.2	0.00	24HR	0.00
29/93	TC10	8.3	0	0.00	0.00	0.2	0.00	24HR	0.00
30/93	TC10	8.2	0	0.00	0.00	0.2	0.00	24HR	0.00
01/93	TC10	8.3	0	0.00	0.00	0.2	0.00	GRAB	0.00
02/93	TC10	7.9	0	1.10	0.00	0.2	0.00	GRAB	0.00
05/93	TC10	7.5	0	4.30	0.00	0.0	0.00	GRAB	0.82
06/93	TC10	7.9	0	[illegible]	4.00	0.2	0.00	GRAB	[illegible]

NPS DAILY WATER QUALITY MONITORING DATA
CUMBERLAND GAP NATIONAL HISTORICAL PARK

	SITE	pH s.u.	TURB ntu	FLOW cfs	TSS ppm	TOT.Fe mg/l	OIL/G ppm	TYPE SAMPLE	PREC inch
===	=====	====	====	======	=======	======	=====	====	====
/93	TC10	7.7	0	1.20	0.00	0.2	0.00	GRAB	0.00
/93	TC10	8.0	0	0.83	0.00	0.2	0.00	GRAB	0.00
/93	TC10	7.9	0	0.90	0.00	0.2	0.00	GRAB	0.00
/93	TC10	7.7	0	1.20	8.00	0.2	0.00	GRAB	0.81
/93	TC10	8.0	1	131.40	0.00	0.2	0.00	GRAB	0.00
/93	TC10	7.9	0	0.87	0.00	0.2	0.00	GRAB	0.00
/93	.TC10	8.0	0	1.00	0.00	0.2	0.00	GRAB	0.08
/93	TC10	8.1	0	1.10	0.00	0.2	0.00	GRAB	0.20
/93	TC10	7.6	0	0.82	4.00	0.2	0.00	GRAB	0.00
/93	TC10	7.5	0	0.73	0.00	0.2	0.00	GRAB	0.00
/93	TC10	7.5	0	0.80	0.00	0.2	0.00	GRAB	0.88
/93	TC10	7.6	0	0.72	0.00	0.2	0.00	GRAB	0.00
/93	TC10	7.6	1	1.10	0.00	0.0	0.00	GRAB	0.00
/93	TC10	7.9	4	1.00	2.00	0.0	0.00	24HR	0.00
/93	TC10	8.1	20	1.10	20.00	0.0	0.00	24HR	0.48
******	******	******	******	******	******	******	******	******	******
		8.3			23.90	0.6	4.50		1.07
		6.9			0.00	0.0	0.00		
ge		7.8			3.73	0.2	0.35		
									** 7.91**